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Financial Services at the Crossroads: Capital Regulation in the Twenty-First Century

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Table of Contents

October 1998
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Financial Services at the Crossroads: Capital Regulation in the Twenty-First Century
Proceedings of a Conference Held at the Federal Reserve Bank of New York on February 26-27, 1998

1 CONFERENCE OVERVIEW: MAJOR THEMES AND DIRECTIONS FOR THE FUTURE
William J. McDonough

7 OPENING REMARKS
Chester B. Feldberg

SESSION 1: IMPACT OF CAPITAL REQUIREMENTS ON BANK RISK TAKING: EMPIRICAL EVIDENCE

15 THE IMPACT OF CAPITAL REQUIREMENTS ON U.K. BANK BEHAVIOUR
Tolga Ediz, Ian Michael, and William Perraudin

23 ASSESSING THE IMPACT OF PROMPT CORRECTIVE ACTION ON BANK CAPITAL AND RISK
Raj Aggarwal and Kevin T. Jacques

33 FAIR VALUE ACCOUNTING AND REGULATORY CAPITAL REQUIREMENTS
Tatsuya Yonetani and Yuko Katsuo

45 MEASURING THE RELATIVE MARGINAL COST OF DEBT AND CAPITAL FOR BANKS
Thuan Le and Kevin P. Sheehan

47 COMMENTARY
Stephen G. Cecchetti

Session 2: Credit Risk Modeling

53 Industry Practices in Credit Risk Modeling and Internal Capital Allocations: Implications for a Models-Based Regulatory Capital Standard
David Jones and John Mingo

61 Credit Risk in the Australian Banking Sector
Brian Gray

71 Portfolio Credit Risk
Thomas C. Wilson

83 Capital Allocation and Bank Management Based on the Quantification of Credit Risk
Kenji Nishiguchi, Hiroshi Kawai, and Takanori Sazaki

95 Commentary
William Perraudin

Distinguished Address

99 Supervisory Capital Standards: Modernise or Redesign?
Edgar Meister

Session 3: Issues in Value-at-Risk Modeling and Evaluation

107 The Value of Value at Risk: Statistical, Financial, and Regulatory Considerations
Jon Danielsson, Casper G. de Vries, and Bjørn N. Jørgensen

109 Horizon Problems and Extreme Events in Financial Risk Management
Peter F. Christoffersen, Francis X. Diebold, and Til Schuermann

119 Methods for Evaluating Value-at-Risk Estimates
Jose A. Lopez

125 Commentary
Beverly Hirtle

Session 4: Incentive-Compatible Regulation: Views on the Precommitment Approach

131 Pilot Exercise—Pre-Commitment Approach to Market Risk
Jill Considine

137 Value at Risk and Precommitment: Approaches to Market Risk Regulation
Arupratan Daripa and Simone Varotto

145 Designing Incentive-Compatible Regulation in Banking: The Role of Penalty in the Precommitment Approach
Shuji Kobayakawa

155 Commentary
Patrick Parkinson

Keynote Address

161 The Role of Capital in Optimal Banking Supervision and Regulation
Alan Greenspan

Session 5: International Capital Allocation at Financial Institutions

171 Building a Coherent Risk Measurement and Capital Optimisation Model for Financial Firms
Tim Shepheard-Walwyn and Robert Litterman

183 Capital from an Insurance Company Perspective
Robert E. Lewis

187 Commentary
Masatoshi Okawa

Session 6: The Role of Capital Regulation in Bank Supervision

191 Formulas or Supervision? Remarks on the Future of Regulatory Capital
Arturo Estrella

201 Deposit Insurance, Bank Incentives, and the Design of Regulatory Policy
Paul H. Kupiec and James M. O'Brien

213 Issues in Financial Institution Capital in Emerging Market Economies
Allen B. Frankel

225 Commentary
Christine M. Cumming

Session 7: The Future of Capital Regulation

231 Capital Regulations: The Road Ahead
Tom de Swaan

237 Risk Management: One Institution's Experience
Thomas G. Labrecque

Conference Overview: Major Themes and Directions for the Future

by William J. McDonough

Conference Overview: Major Themes and Directions for the Future

William J. McDonough

This special issue of the *Economic Policy Review* presents the proceedings of "Financial Services at the Crossroads: Capital Regulation in the Twenty-First Century," a conference hosted by the Federal Reserve Bank of New York in partnership with the Bank of England, the Bank of Japan, and the Board of Governors of the Federal Reserve System. The conference, held in New York on February 26-27, 1998, examined a wide variety of topics: the impact of capital standards on bank risk taking, new industry approaches to quantifying risk and allocating capital, proposals for reforming the current structure of capital rules, and the role of capital regulation in bank supervision.

Although the speakers at the conference took very different positions on several regulatory capital issues, their papers all directly or indirectly point to one question: Where do we go from here? In this overview, I will try to summarize some of the main themes that emerged from the papers and discussion. I will then suggest what these themes imply for the choices facing financial institutions and their supervisors in the years ahead and for the future of capital regulation as a whole.

William J. McDonough is the president of the Federal Reserve Bank of New York.

Evolution in Risk Measurement and Management Practices Is Continuous

Risk measurement and management practices have evolved significantly since the Basle Accord was adopted in 1988, and there is every reason to believe that this evolution will continue. In fact, the papers and discussion at this conference suggest that change is the natural state of the world in risk management and that no model or risk management approach can ever be considered final.

Even in a well-developed risk measurement area such as value-at-risk modeling for market risk exposures, innovations and fresh insights are emerging. These advances are the outgrowth of both academic research efforts and financial institutions' day-to-day experience with value-at-risk models. The papers presented in the session on value-at-risk modeling exemplify how academic research can suggest new approaches to addressing real-world problems in risk measurement.

Evolution is even more evident in the developing field of credit risk modeling. As the papers in the credit risk session demonstrate, advances in credit risk measurement are occurring along several fronts. First, financial institutions are refining the basic empirical techniques that they use to assess credit risk. In particular, banks have developed enhanced methods of evaluating portfolio effects—effects shaped by credit risk concentrations and correlations in defaults and credit losses across different positions—and have improved their ability to measure the impact of these effects on the overall credit risk exposure of an institution. In addition, the new empirical techniques allow financial institutions to assess more accurately the risk that each transaction contributes to the credit portfolio as a whole, as well as the risk of each transaction on a stand-alone basis. Thus, credit risk models, although still in the early days of development and implementation, have the potential to deepen banks' and supervisors' understanding of the complete risk profile of credit portfolios.

The discussion during the credit risk session revealed that there are many approaches to credit risk modeling and a variety of applications. The diversity of ideas about credit risk modeling is the sign of a healthy climate of exploration and development, which should lead to improved modeling techniques and a more effective use of models' output by financial institutions making internal risk management, capital allocation, and portfolio decisions.

Rapid Changes in Risk Management Require Corresponding Changes in Supervisory Direction

The rapid evolution in financial institutions' risk management practices presents a substantial challenge to supervisors. As several of the conference papers make clear, the impact of supervisory rules and guidelines—especially regulatory capital requirements—can vary substantially as the financial condition, risk appetite, and risk management approaches used by financial institutions change, both across institutions and for a given institution over time. In an environment in which financial institutions are developing new and increasingly complex methods of assuming and managing risk exposures, regulatory capital requirements and other supervisory practices must continually evolve if they are to be effective in meeting supervisory objectives. Simply keeping up with innovations in the measurement and control of risk is therefore a vital task for supervisors, although merely a starting point.

The speakers in the opening session of the conference argued that regulatory capital requirements and other supervisory actions can have significant effects on the risk-taking behavior of financial institutions. In response to capital requirements, banks adjust their risk profiles, altering the overall level of risk undertaken and shifting their exposures among different types of risk that receive different treatments under regulatory rules. Further, the speakers indicated that each bank's response to changes in regulatory capital requirements will depend on the capital constraints faced by the bank. Banks under more binding capital constraints may have greater incentives to engage in "risk shifting" and other practices to reduce the constraints from regulatory capital requirements. Taken together, these findings suggest that supervisors must pay attention to the incentive effects of regulation as well as the evolution of risk management practice in the industry.

The discussion in several sessions offers a corollary to this last point, namely, that supervisors have many ways to adapt their practices in response to industry developments. They can, for example, build on the incentives that already motivate financial institutions to improve their risk measurement and management capabilities. Expanding the use of risk measurement models for regulatory capital purposes—as some observers now suggest in the case of credit risk models—is only one way in which supervisors can take advantage of existing advances in risk management within financial institutions. Improved risk management techniques can also enhance the ability of supervisors to monitor the risk profiles of financial institutions and to assess both the strengths and the vulnerabilities of the financial institutions under their charge. Although the focus of this conference is regulatory capital, we should not lose sight of the fact that supervisors can use innovations in risk management to deepen their understanding of the risks facing financial institutions.

"One-Size-Fits-All" Capital Rules Will Be Ineffective

As financial institutions become more complex and more specialized, "one-size-fits-all" capital rules are more likely to be ineffective or to induce unintended and undesirable reactions. Perhaps the most significant theme to emerge from the discussion at the conference is the idea that such "one-size-fits-all" approaches to capital regulation will fail in the long run. Conference participants suggested that in the future, supervisory practice and capital regulation will be based less on specific rules and prescriptions and more on a system of general principles for sound and prudent management. This change will come about in part because supervisors will find it harder to formulate precise rules to regulate the increasingly sophisticated activities of financial institutions. However, a more important reason for the change—raised in several of the papers in this conference—is the difficulty of crafting effective regulatory capital requirements when the circumstances and characteristics of individual financial institutions heavily influence the way in which each institution responds to any particular set of rules. Thus, a single rule or formula could have quite different effects across institutions—effects that could diverge markedly from those intended by supervisors.

This last point was made forcefully in the session on incentive-compatible regulation and the precommitment approach and in the session on the role of capital regulation in supervision. Papers presented in both sessions stressed that effective regulatory capital regimes must take into account the risk profile and characteristics of individual institutions. Some participants suggested that this principle should guide the choice of a scaling factor in the internal models approach to market risk capital requirements; others applied it to the choice of a penalty in the precommitment approach; still others related it to the overall nature and structure of regulatory capital requirements.

This principle also emerged, in a slightly different form, in the sessions on value-at-risk and credit risk modeling. The papers presented in these sessions used a variety of modeling approaches, reflecting in part contrasting views of the objectives of risk modeling. Participants took different positions on the best method of modeling market and credit risk and of determining an institution's optimal level of capital, suggesting that no single formula for setting capital requirements would be optimal for all institutions.

Financial Institutions and Supervisors Face Challenges for the Future

The issues that I have discussed define the challenges facing financial institutions and supervisors entering the twenty-first-century world of supervisory capital regulation. For financial institutions, one key challenge is to determine how best to measure the types of risk they face. The discussion over the past two days has highlighted a number of areas in credit risk modeling that deserve further attention—including the shortage of historical data on default and credit loss behavior, the difficulty of comparing models and modeling approaches across institutions, and the need to develop methods of model validation. Although these issues are indeed the focus of much attention, banks and other financial institutions are also attempting to understand and manage other important forms of risk—such as operational and legal risk—that are just as complex and less easily quantifiable. Finally, financial institutions face the challenge of implementing advances in risk modeling in a coherent and systematic fashion, whether for pricing, portfolio management, or internal capital allocation.

For supervisors, the most important challenge involves developing an approach to capital regulation that works in a world of diversity and near-constant change. The papers presented at this conference provide evidence of an active effort to meet this challenge. Supervisory capital requirements will undoubtedly continue to evolve, reflecting innovations in risk management and measurement at financial institutions as well as changes in supervisors' views of the appropriate capital regime. Whatever the approaches eventually adopted, the next generation of supervisory capital rules must take into account the vital role of incentives in determining the behavior of financial institutions.

Financial institutions and supervisors alike must consider how the adoption of new approaches to capital regulation will affect the overall level of capital in financial institutions and the relationship between required capital and economic capital. To this end, we must address a series of key questions about capital regulation: What risks should be covered through capital requirements? How do we decide on the level of prudence? What is the role of minimum capital requirements? And what is the supervisor's role in the assessment of capital adequacy? A number of the papers given over the past two days have taken up these vital questions, and the next step is to develop our thinking on these key issues in a more systematic way.

More fundamentally, we need to give fuller consideration to the purpose of capital, as it is seen by financial institutions on the one hand and by supervisors and central bankers on the other. In addition, we need to understand the relationship between these two perspectives, and to evaluate how this relationship could influence capital adequacy and the incentives to assume and manage risk under various regulatory capital frameworks. This task involves developing a better grasp of the objectives of capital regulation in light of the rapidly changing character of financial institutions, the availability of new risk management techniques, and the need for systemic stability.

The challenges highlighted here create a substantial agenda for future research. The need for additional research, together with the enormous interest that this conference has generated, suggests that it would be wise to establish a forum for further analysis and discussion of capital regulation issues. As a first step, a series of seminars on technical issues might be held. These seminars would be conceived as an open exchange of ideas rather than a decision-making or advisory initiative. Such efforts to foster an ongoing dialogue and to build consensus among academics, supervisors, and industry practitioners on regulatory issues could be extremely beneficial. Certainly, the resolution of these issues—or the failure to resolve them in an intelligent fashion—will shape the future course of capital regulation for financial institutions.

Opening Remarks

by Chester B. Feldberg

Opening Remarks

Chester B. Feldberg

On behalf of the Federal Reserve Bank of New York, I would like to welcome all of you to New York City and to our conference "Financial Services at the Crossroads: Capital Regulation in the Twenty-First Century." Today's large and distinguished audience reflects our good fortune in deciding early last year to hold a conference on this particular topic at this particular time. We have more than 250 registered participants as well as many observers from throughout the Federal Reserve System. Among those attending today are fifteen members of the Basle Committee on Banking Supervision, virtually all members of the Capital Subgroup of the Basle Committee, several senior U.S. financial supervisors, and representatives of financial institutions from more than fifteen countries. The academic community is also well represented.

Although we at the New York Fed are the hosts of this conference, the conference has been organized in close collaboration with the Bank of England, the Bank of Japan, and our colleagues at the Board of Governors of the Federal Reserve System. It is a sure sign of how truly global our financial system has become that the very first step we took in planning today's conference was to enlist the active participation of those institutions. I would like to thank the individuals from those institutions who helped arrange the conference—Patricia Jackson of the Bank of England, Masatoshi Okawa of the Bank of Japan, and Allen Frankel of the Board of Governors—as well as the team here in New York, led by Bev Hirtle, for their outstanding work.

It was just about a year ago that we began planning the conference. At that time, we were deeply engaged in several capital-related activities: the completion and implementation of the Market Risk Amendment to the Basle Accord, a Federal Reserve study of credit risk modeling, the development of a supervisory approach to credit derivatives, and the assessment of a new round of securitization activity. All of these efforts suggested that it was an appropriate time to hold a forum on capital regulation.

Further stimulus was provided by developments in the research and financial communities. We were seeing new techniques of risk management—techniques that relied on innovations in analytical and statistical approaches to measuring risk. We were also seeing an increasing integration of traditional banking functions, such as commercial lending and interest rate risk management, with the full range of capital markets activities. Finally, we could not ignore the widening gap between the sophisticated risk management practices of financial institutions and the

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simpler approach to credit risk capital requirements embodied in our current capital standards.

It is important to remember that the original Basle Accord incorporated what was, in the mid-to-late 1980s, state-of-the-art assessment of capital adequacy at large financial institutions. Partly for this reason, the Basle Accord was, and still is, viewed as a landmark achievement of the Basle Committee and a milestone in the history of banking supervision.

The adoption of the Accord was quickly followed by a critique of everything from the original risk-weighting scheme to the handling of derivatives-related credit exposures. The Basle Committee has responded by amending the Accord several times to update it and to incorporate the new capital standards for market risks—standards that were seen as necessary even at the time the Accord was first published. Thus, more than most international agreements, the Accord is truly a living document that has continued to evolve with advancing financial industry practices.

Evolution is almost too soft a word to describe the changes we have witnessed in the financial sector over the decade since publication of the Accord. Innovation in this sector seems to come in bursts. Consider, for example, the development of derivatives in the early 1980s and the growth of option-related instruments in the late 1980s. And in the late 1990s, innovation in credit risk management appears to be reaching high gear. Indeed, in the relatively brief period since we announced this conference last spring, we have seen the launch of credit-modeling packages by major financial market participants; new uses for credit derivatives and credit models in the securitization of commercial credit; and, for supervisors, a sure sign that an innovation has arrived—the first problems relating to Asian credit derivatives.

Credit risk is without question the most important risk for banks, but not just for banks. I suspect that when one tallies the losses racked up in the securities, insurance, asset management, and finance company industries, no small measure of the total losses can be attributed to credit risk in some form. Therefore, how we adapt our supervisory approaches and our capital requirements to credit-risk-related innovation has high stakes both for financial institutions generally and for the global supervisory community.

Credit risk, however, is not the only important front on which change has been extraordinarily rapid. The pace of convergence among the banking, securities, and insurance industries and their various product offerings is accelerating. For that reason, we have entitled this conference "Financial Services at the Crossroads" rather than "Banking at the Crossroads."

As the number of true financial conglomerates steadily increases and the risks faced by the different industries within the financial sector become more alike, we in the supervisory community are increasing our dialogue on such issues as corporate governance, risk management, and capital adequacy, especially through organizations such as the Joint Forum. One result of this dialogue is a growing recognition of the value of choosing regulatory approaches that can accommodate a wide range of financial firms and activities. In addition, we are working to unify our vocabulary and to reach a shared understanding of key risk concepts and practices. Certainly, a foundation of common risk concepts and practices would contribute significantly to greater transparency within the financial sector.

These are broad issues. But for this conference to achieve its full purpose, it must take a broad perspective. One benefit of an academic-style conference, with a call for papers and a long lead time for paper preparation, is the ability to search the horizon for as many creative ideas as possible.

Given our intention to represent a wide range of thought on capital regulation, it may surprise you to see that half of the conference sessions with prepared papers deal with risk modeling. I conclude from the prevalence of this topic among the papers submitted to us that the financial community, including the supervisory community, has moved resolutely and irrevocably to incorporate sophisticated financial techniques into its thinking about capital, risk management, and financial condition. Nevertheless, as

I believe you will see throughout the program, risk modeling is itself a mansion with many, many rooms, which we and the financial community have just begun to explore. Therefore, in searching for approaches to twenty-first-century capital standards, we should not stop at the very first room. Moreover, the growing industry reliance on risk modeling itself raises many questions about how supervisors should make use of information from risk models and the extent to which we should accept a financial institution's own assessment of its capital adequacy, whether assessed through models or other means. Several papers in the second half of the program will discuss these issues.

Our hope is that this conference can accelerate the development of a consensus between the public and private sectors on an agenda for twenty-first-century capital regulation. My special focus is on the work of the Basle Committee, of which I am pleased to be a member, since the Committee has played and continues to play a leadership role in the development of capital standards for the industry.

I am very aware that the process of developing supervisory policy at the international level will take considerable time. We need time to educate ourselves about the impact of our current capital standards and to examine how those standards are affected by new developments, especially innovations in credit risk management. We need time to study the possible responses to such developments and the full ramifications of the responses. We need time to choose carefully among the various options available. And we need time to plan for implementation and transition. The need for such a long period of preparation suggests strongly to me that now is the right moment to devote the better part of two intensive days to a conference on twenty-first-century capital standards.

Once again, I am delighted to welcome you to the Federal Reserve Bank of New York. I am confident that you will find the conference both provocative and productive.

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SESSION 1

IMPACT OF CAPITAL REQUIREMENTS ON BANK RISK TAKING: EMPIRICAL EVIDENCE

Papers by

Tolga Ediz, Ian Michael, and William Perraudin

Raj Aggarwal and Kevin T. Jacques

Tatsuya Yonetani and Yuko Katsuo

Thuan Le and Kevin P. Sheehan

Commentary by

Stephen G. Cecchetti

The Impact of Capital Requirements on U.K. Bank Behaviour

Tolga Ediz, Ian Michael, and William Perraudin

CAPITAL REQUIREMENTS AND THEIR POTENTIAL IMPACT ON BANK BEHAVIOUR

The 1988 Basle Accord obliges banks to maintain equity and quasi-equity funding equal to a risk-weighted proportion of their asset base. Regulators' intentions in adopting the Accord were, first, to reinforce financial stability, second, to establish a level playing field for banks from different countries, and third, in the case of some countries, to reduce explicit or implicit costs of government-provided deposit guarantees. But extensive reliance by banking supervisors on capital requirements inevitably begs questions about the possibly distortionary impact on bank behaviour.

The most obvious possible, and undesirable, impact on bank behaviour of risk-weighted capital requirements is that excessive differentials in the weights applied to different categories of assets might induce banks to substitute away from highly risk-weighted assets. In the early 1990s, U.S. banks shifted sharply from corporate lending to investing in government securities, and many commentators and researchers have attributed this shift to the post–Basle Accord system of capital requirements.

While papers such as Hall (1993), Haubrich and Wachtel (1993), Calem and Rob (1996), and Thakor (1996) make a persuasive case that capital requirements played a role in this switch, the conclusion is not entirely uncontroversial. Hancock and Wilcox (1993), for example, present evidence that U.S. banks' own internal capital targets explain the decline in private sector lending better than do the capital requirements imposed by regulators. Furthermore, the fact that capital requirements affect bank behaviour does not of course imply that the impact is undesirable. Bank supervisors must judge whether the induced levels of capital are adequate, or not, given the broad goals of regulation.

A second potential, undesirable impact on banks of risk-weighted, capital requirements of the Basle Accord–type is that banks may shift within each asset category toward riskier assets. Imposing equal risk weights on different private sector loans may make the safer, lower yielding assets less attractive, leading to substitution toward higher risk investments. Kim and Santomero (1988) show formally how a bank that maximises mean-variance preferences and faces uniform proportional capital requirements may substitute toward higher risk assets.

Tolga Ediz is an economist and Ian Michael a senior manager in the Regulatory Policy Division of the Bank of England. William Perraudin is a professor of finance at Birkbeck College, University of London, and special advisor to the Regulatory Policy Division of the Bank of England.

Theoretical contributions by Keeley and Furlong (1989, 1990) and Rochet (1992) show that such substitution effects are sensitive to assumptions about banks' objective functions and to whether or not asset markets are complete. The extent to which banks are affected by this kind of distortion therefore remains an empirical question. Several recent econometric studies have looked for substitution effects attributable to capital requirements using data on U.S. banks. See, for example, Shrieves and Dahl (1992), Haubrich and Wachtel (1993), and Jacques and Nigro (1997).

Capital Requirements in the United Kingdom

All the empirical papers cited above draw on the U.S. experience. U.S. data have many advantages, most notably the very large number of banks for which data are available and the detailed information one may obtain on individual institutions. Nevertheless, it is important to examine the impact of capital requirement systems operating in other countries. Although the Basle approach provides a basic framework of minimum capital standards, regulators in different countries have supplemented it with a range of other requirements that deserve empirical investigation. Furthermore, data from other (that is, non-U.S.) banking markets may shed interesting light on the effects of capital requirements simply because they constitute a largely independent sample. The impact of capital requirements can only really be studied by looking at cross-sectional information on banks. Since U.S. banks are inevitably subject to large common shocks, banking industries in other countries provide a valuable additional source of evidence.

In our paper titled "Bank Capital Requirements and Regulatory Policy" (1998), we employ confidential supervisory data for British banks to address some of the issues outlined above. The panel data set we use comprises quarterly balance sheet and income data from ninety-four banks stretching from fourth-quarter 1989 to fourth-quarter 1995. The two questions we are primarily interested in are (a) does pressure from supervisors affect bank capital dynamics when capital ratios approach their regulatory minimum, and (b) by adjusting which items in their balance sheets do banks increase their capital ratios when subject to regulatory pressure?

Bank Capital Regulation in the United Kingdom

To understand the interest and implications of our study, it is important to have a clear idea of the operation of bank capital regulation in the United Kingdom. While the U.K. approach is fully consistent with the basic standards laid down in the Basle Accord, various additional requirements are placed on banks by U.K. supervisors. First, U.K. supervisors set two capital requirements—a "trigger ratio," which is the minimum capital ratio with which a bank must comply, and a "target" ratio set somewhat above the trigger ratio. The gap between the target and the trigger acts as a buffer in that regulatory pressure is initiated when a bank's risk asset ratio (RAR) falls below the target. If the RAR falls below the trigger ratio, supervisors take more drastic action, and ultimately may revoke a bank's license.

Another important feature of U.K. practice is that supervisors specify bank-specific capital requirements. Banks adjudged to be risky by the supervisors must meet higher capital requirements than less risky institutions. Risky in this context may reflect supervisors' evaluation of the bank's loan book or possibly their perception that there exist weaknesses in systems of control or in the competence of management. For most U.K. banks, capital requirements exceed the Basle minimum of 8 percent. The ability to vary a bank's capital requirement administratively provides regulators with a very useful lever with which they can influence the actions of the bank's management.

The empirical implications of the system described above are (a) that one might expect that banks experiencing or fearing regulatory pressure will seek to boost their capital ratios when their RARs enter a region above the regulatory minimum, and (b) that changes in a bank's trigger ratio will induce a change in the bank's capital dynamics. We investigate these hypotheses below.

Data Description

Before looking at bank capital dynamics statistically, it is useful to examine our data to understand its basic structure. In Chart 1, we provide a scatter diagram of changes over a quarter in banks' RARs (pooled across banks and time periods) plotted against the lagged level of the RAR. Rather than expressing the lagged RAR in its natural units, we prefer to measure it in terms of deviations from the trigger ratio divided by the sample standard deviation of the RAR for each individual bank. This approach makes sense because banks are likely to change their behaviour, boosting their RARs, when they are in danger of hitting their regulatory minimum. The volatility of the RAR (which varies substantially across different banks) is just as important, therefore, as the actual distance in percent from the current RAR to the trigger.

To facilitate interpretation of Chart 1, we include a simple OLS linear regression line of RAR changes on lagged RAR levels. As one might expect, this line is downward sloping, reflecting the fact that low initial RAR levels induce banks to rebuild their capital ratios. Perhaps the most interesting feature of the chart, however, is the fact that a clear nonlinearity is apparent in that deviations from the regression line for low levels of the RAR are consistently positive. This bears out our hypothesis that there exists a regime switch in bank capital dynamics in the region immediately above the trigger level.

The second question that interested us is exactly how banks go about increasing their capital ratios when they are low. Either banks might cut back private sector loans that bear high risk weighting in favour of government securities, for example, which attract low risk weights. Alternatively, banks might boost their capital directly by issuing new equity or by cutting dividends. As we noted in the introduction, the substitution by banks toward low-risk-weighted assets, which one might term the credit crunch hypothesis, has been thoroughly discussed in the case of U.S. banks in the early 1990s by a series of papers.

Chart 2 shows the change in 100-percent-weighted assets as a ratio to total risk-weighted assets (TRWA) plotted against the lagged level of the RAR. Once again, the RAR level is expressed as a deviation from the bank-specific trigger and is scaled by the standard deviation of the RAR appropriate for each bank. The chart indicates that there exists only a slight positive relationship between changes in 100-percent-weighted assets and lagged RARs. Furthermore, the nonlinearity clearly evident in Chart 1 appears not to be present. Thus, banks only slightly reduce their holdings of 100-percent-weighted assets when their RARs fall close to trigger levels, and the credit crunch hypothesis appears not to be borne out.

Charts 3 and 4 repeat Chart 1 except for different capital ratios. Respectively, they show changes in Tier 1 and Tier 2 capital as ratios to total risk-weighted assets plotted against the lagged level of the RAR. Tier 1 represents narrow capital, mainly consisting of equity and

Chart 1

Change in Risk Asset Ratio

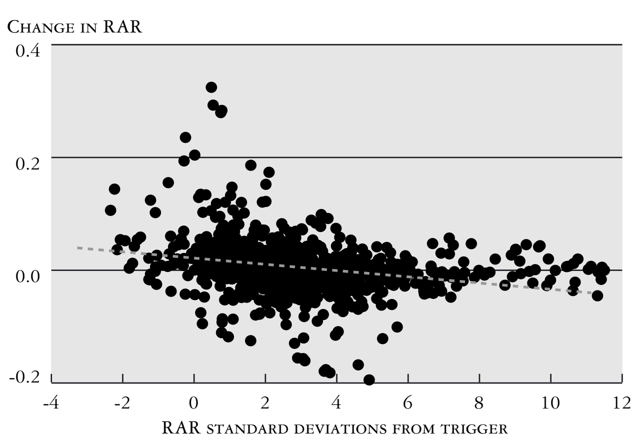


Chart 2

Change in 100-Percent-Weighted Assets/TRWA

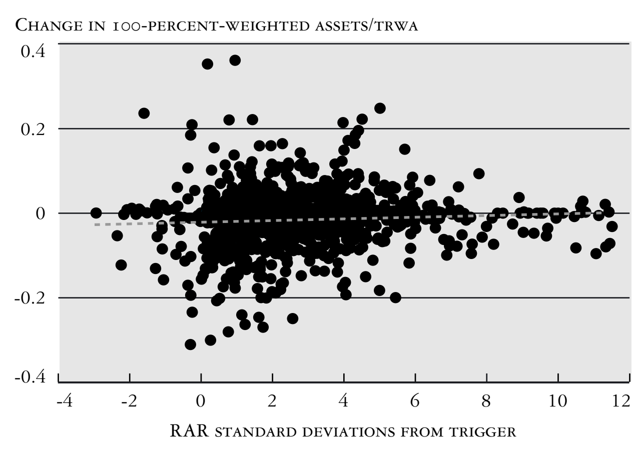
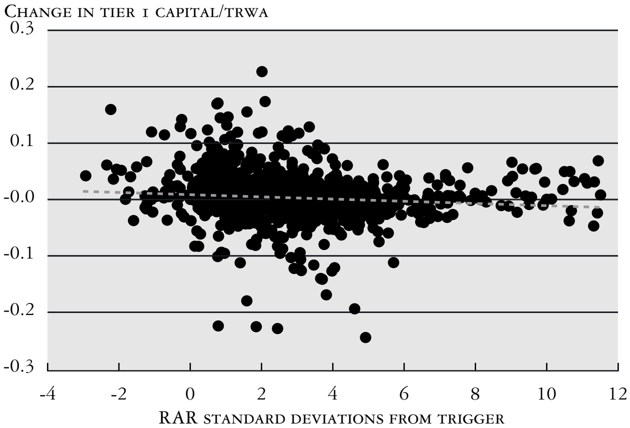


Chart 3

CHANGE IN TIER 1 CAPITAL/TRWA



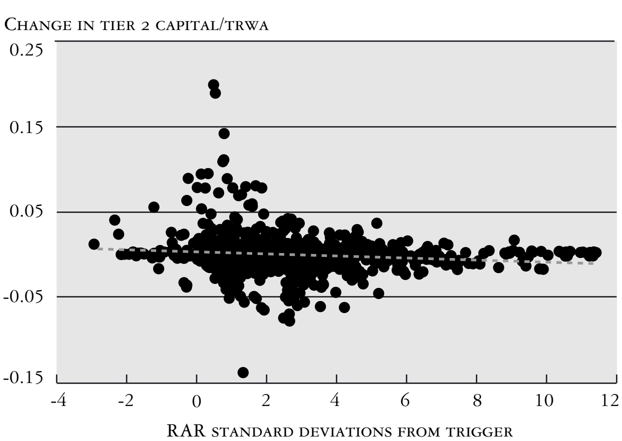
retained earnings. Recall that the Basle Accord specifies that banks have to hold a ratio of Tier 1 capital to risk-weighted assets of at least 4 percent. Tier 2 consists of broad capital less narrow capital and primarily comprises subordinated debt and other equity-like debt instruments. Both the Tier 1 and the Tier 2 scatter plots exhibit strong negative relationships between capital and the distance of the RAR from the trigger ratio.

REGRESSION ANALYSIS

Although scatter plots provide valuable clues to the bivariate relationship between capital changes and the lagged level of capital, a formal regression analysis must be

Chart 4

CHANGE IN TIER 2 CAPITAL/TRWA



performed if one wishes to understand the impact on capital changes of regulatory pressure, holding other influences on capital constant. This is important because when a firm falls into financial distress, it may seek to adjust its capital in line with its own internally generated capital targets, even without intervention by regulators (see the discussion in Hancock and Wilcox [1993]). We, therefore, formulate a dynamic, multivariate panel regression model in which changes in capital ratios depend on the lagged level of the ratio, a range of conditioning variables describing the nature of the bank's business and its current financial health (these proxy for the bank's internal capital target), and variables that may be regarded as measuring regulatory pressure. Formally, our model may be stated as:

$$Y_{n,t+1} - Y_{n,t} = \beta_0 + \sum_{j=1}^{N} \beta_j X_{n,t,j} + \gamma Y_{n,t} + \varepsilon_{n,t},$$

where $E(\varepsilon_{n,t}) = E(X_{n,t,j}\varepsilon_{n,t}) = 0$, t indicates the time period, and where $X_{n,t,j}$ $j = 1, 2, \ldots..N$ are a set of regressors.

$$\varepsilon_{n,t+1} = \rho\varepsilon_{n,t} + \nu_{n,t} \quad \forall n, t,$$

where $E(\nu_{n,t}) = 0$ for all n, t, and $E(\nu_{n,t}\nu_{m,s}) = 0$ for all t, s, n, m except when $t = s$ and $n = m$. To include random effects, we suppose that for any bank, $E(\nu_{n,t}^2) = \sigma_n^2$.

Our conditioning variables designed to proxy the bank's own internal capital target include net interest income over total risk-weighted assets, fee income over total risk-weighted assets, bank deposits over total deposits, total off-balance-sheet exposures over total risk-weighted assets, provisions over total risk-weighted assets, profits over total risk-weighted assets, and 100-percent-weighted assets over total risk-weighted assets. The net interest income, fee income, and 100-percent-weighted asset variables reflect the nature and riskiness of the bank's operations. Bank deposits and off-balance-sheet exposure variables reflect the bank's vulnerability to runs on deposits although they may also reflect the degree of financial sophistication of the bank and its consequent ability to economise on capital. Total profit and loss and provisions variables indicate the bank's state of financial health.

We measure regulatory pressure in two ways. First, we incorporate a dummy variable that equals one if the bank has experienced an upward adjustment in its trigger ratio in the previous three quarters. Second, we include a dummy that equals unity if the RAR falls close to the regulatory minimum. As we argue above, the degree that a bank is "close" to its trigger depends not just on the absolute percentage difference between the current RAR and the trigger but also on the volatility of the RAR. Hence, we calculate the dummy in such a way that it is unity if the RAR is less than one bank-specific standard deviation above the bank's trigger. Thus, our hypothesis is that there exists a zone above the trigger in which the bank's capital ratio choices are constrained by regulatory pressure. In this respect, our study is comparable to Jacques and Nigro (1997).

The dummy associated with a one-standard-deviation zone above the trigger may be regarded as introducing a simple regime switch in the model for low levels of the RAR. To generalise this regime switch, we also estimate switching regression models in which all the parameters on the conditioning variables (not just the intercept) are allowed to change when the RAR is less than one standard deviation above the trigger. This specification allows for the possibility that all the dynamics of the capital ratio change when the bank is close to its regulatory minimum level of capital.

In formulating our panel model, we adopt a random rather than a fixed-effects specification. We are not so interested in obtaining estimates conditional on the particular sample available that is the usual interpretation of the fixed-effect approach (see Hsiao [1986]) and so the random-effects approach seems more appropriate. Thus, we suppose that the variance of error terms has a bank-specific component. Furthermore, we suppose that the residuals are AR(1). The latter assumption seems natural as one might expect shocks to register in bank capital ratios over more than a single quarter. The fact that error terms are autocorrelated somewhat complicates estimation since our model contains lagged endogenous variables. To avoid the biases in parameter estimates this would otherwise induce, we employ the instrumental variables approach introduced by Hatanaka (1974).

Table 1 reports regression results for the case in which the dependent variable is the RAR. Note that estimates in

Table 1
RAR AND 100-PERCENT-WEIGHTED ASSETS REGRESSION RESULTS

	RAR			100-Percent-Weighted Assets/TRWA		
		< trig + 1 s.d.	> trig + 1 s.d.		< trig + 1 s.d.	> trig + 1 s.d.
Constant	0.05	0.08	-0.38	-0.01	-0.11	-0.48
	(1.38)	(1.63)	(-0.73)	(-0.28)	(-2.21)	(-3.17)
Change in trigger dummy	0.27	1.46	—	-0.16	-0.58	—
	(1.42)	(1.94)	—	(-0.90)	(-0.58)	—
Fee income/net interest income	0.00	-0.01	0.00	0.00	-0.00	0.01
	(0.40)	(-0.17)	(0.35)	(0.06)	(-0.15)	(0.70)
Net interest income/TRWA	0.04	4.57	-0.66	1.30	-8.95	1.72
	(0.02)	(0.41)	(-0.23)	(0.67)	(-1.71)	(0.83)
Deposits from banks/TRWA	-0.19	0.54	-0.30	0.14	-0.12	0.32
	(-1.82)	(1.88)	(-2.47)	(1.47)	(-0.87)	(2.49)
(RAR trigger) less than 1 s.d.	0.44	—	—	-0.03	—	—
	(4.64)	—	—	(-0.39)	—	—
Off-balance-sheet assets/TRWA	2.21	2.74	2.68	-1.01	-1.57	-0.43
	(1.65)	(0.80)	(1.64)	(-0.90)	(-0.62)	(-0.29)
Profit and loss/TRWA	-3.93	-8.35	-4.45	-1.42	-1.41	-3.58
	(-1.13)	(-0.57)	(-1.27)	(-0.49)	(-0.14)	(-1.29)
Total provisions/TRWA	1.29	3.96	0.86	-0.59	-1.08	-0.18
	(1.26)	(1.32)	(0.70)	(-0.54)	(-0.27)	(-0.16)
100-percent-weighted assets/TRWA	0.19	0.31	0.05	—	—	—
	(1.52)	(1.05)	(0.32)	—	—	—
Lagged dependent variable	-0.44	-2.62	0.77	-0.08	-1.64	-0.06
	(-0.81)	(-0.92)	(1.13)	(-1.14)	(-3.03)	(-0.72)

Notes: TRWA and RAR denote total risk-weighted assets and risk/asset ratio. Data are for ninety-four banks from fourth-quarter 1989 to fourth-quarter 1995. Estimates are scaled by 100. All regressions employ the Hatanaka (1974) method. *t*-statistics appear in parentheses.

the table are scaled by 100. Our estimates strongly suggest that capital requirements significantly affect banks' capital ratio decisions. The coefficient of the regime dummy is positive and significant. The point estimate implies that banks increase their RARs by around 1/2 percent per quarter when their capital approaches the regulatory minimum. In addition, we find that banks raise their RAR by 1/3 percent per quarter following an increase in their trigger ratio by the supervisors.

In columns 2 and 3 of Table 1, we report estimates for a switching regression model in which the coefficients on all the conditioning variables are allowed to change depending on whether the RAR is greater than or less than one standard deviation above the trigger. One might note that the impact of being near to or far from the trigger appears to change little between the simpler model and this generalised switching regression model. In the first case, the parameter estimate on the dummy for proximity to the trigger was 1/2 percent, while the difference between the two intercepts in the switching regression model is also around 1/2 percent. By contrast, the magnitude of the dummy for recent increases in the trigger is far greater when we relax the specification, rising from 1/3 percent in the simpler model to 1 1/2 percent in the switching regression model.

One should also note that the coefficients on the conditioning variables in the regressions all have plausible signs. For example, higher profits reduce capital ratios while higher provisions or 100-percent-weighted assets increase them. It is also interesting that in the switching regressions model, banks with greater reliance on bank deposits tend to increase their capital ratios. Overall, we conclude that capital requirements induce banks to increase their capital ratios even after one allows for internally generated capital targets. This conclusion is in contrast to that of Hancock and Wilcox (1993) in their study of U.S. banks.

The second question we are interested in is exactly how banks achieve changes in their capital ratios if they are subjected to regulatory pressure. The most obvious possibilities are either that they adjust the asset side of their balance sheets, for example, substituting government securities

Table 2
TIER 1 AND TIER 2 CAPITAL REGRESSION RESULTS

	Tier 1 Capital/TRWA			Tier 2 Capital/TRWA		
		< trig + 1 s.d.	> trig + 1 s.d.		< trig + 1 s.d.	> trig + 1 s.d.
Constant	0.08	0.15	-0.88	-0.05	-0.08	0.11
	(1.95)	(3.03)	(-2.64)	(-3.40)	(-3.63)	(0.83)
Change in trigger dummy	-0.15	2.61	—	0.06	0.13	—
	(-0.69)	(1.97)	—	(0.74)	(0.27)	—
Fee income/net interest income	0.00	0.02	0.00	0.00	0.01	0.00
	(0.32)	(0.41)	(0.22)	(0.63)	(0.31)	(0.38)
Net interest income/TRWA	3.15	3.25	7.72	-0.20	0.08	-3.16
	(1.49)	(0.37)	(3.89)	(-0.23)	(0.02)	(-3.54)
Deposits from banks/TRWA	-0.15	0.40	-0.19	-0.03	-0.00	-0.03
	(-1.52)	(1.77)	(-1.85)	(-0.75)	(-0.01)	(-0.50)
(RAR trigger) less than 1 s.d.	0.17	—	—	0.15	—	—
	(2.54)	—	—	(3.58)	—	—
Off-balance-sheet assets/TRWA	2.22	-0.40	3.29	0.38	2.39	0.18
	(2.04)	(-0.14)	(2.73)	(1.04)	(2.06)	(0.28)
Profit and loss/TRWA	-2.73	-4.86	-3.99	-1.53	-8.63	0.10
	(-0.87)	(-0.38)	(-1.55)	(-1.15)	(-1.53)	(0.08)
Total provisions	-0.04	3.83	-2.71	-0.22	-1.85	0.85
	(-0.04)	(1.49)	(-2.68)	(-0.53)	(-1.14)	(1.89)
100-percent-weighted assets/TRWA	0.16	-0.32	0.35	0.09	0.23	-0.09
	(1.44)	(-1.25)	(2.52)	(1.86)	(1.75)	(-1.61)
Lagged dependent variable	0.52	-3.89	1.86	-3.09	-0.78	-2.82
	(1.13)	(-1.83)	(4.38)	(-4.90)	(-0.37)	(-3.27)

Notes: TRWA and RAR denote total risk-weighted assets and risk/asset ratio. Data are for ninety-four banks from fourth-quarter 1989 to fourth-quarter 1995. Estimates are scaled by 100. All regressions employ the Hatanaka (1974) method. *t*-statistics appear in parentheses.

(which attract low-risk weights in bank capital calculations) for private sector loans (which attract high-risk weights), or alternatively that they raise extra capital by issuing securities or by retaining earnings.

The three right-hand-columns of Table 1 show regressions of changes in 100-percent-weighted assets as a ratio to total risk-weighted assets on the lagged level of this ratio and on the same conditioning variables as those included in the RAR regressions. Although the parameters for the two regulatory intervention dummies have the right signs, they are insignificant. The magnitudes of the point estimates are fairly small as well. In general, *t*-statistics are low, suggesting that the 100-percent-weighted asset ratio does not behave in a statistically stable way over time and across banks. In summary, it seems fair to conclude that banks do not significantly rely on asset substitution away from high-risk-weighted assets to meet their capital requirements as they approach the regulatory minimum.

Table 2 reports results for regressions similar to our RAR regressions reported above but using different capital ratios. Both the Tier 1 and Tier 2 capital ratio regressions we perform indicate that banks raise their ratios when they come close to their triggers. The response of banks to increases in their triggers is much higher for Tier 1 than for Tier 2 capital, suggesting that the bulk of the adjustment comes through increases in narrow capital. The adjustment in capital that occurs when banks are close to their triggers is more evenly spread across the two categories of capital.

CONCLUSION

In this paper, we summarise some of the results of Ediz, Michael, and Perraudin (1998) on the impact of bank capital requirements on the capital ratio choices of U.K. banks. We use confidential supervisory data including detailed information about the balance sheet and profit and loss of all British banks over the period 1989-95.

The conclusions we reach are reassuring in that capital requirements do seem to affect bank behaviour over and above the influence of the banks' own internally generated capital targets. Furthermore, banks appear to achieve adjustments in their capital ratios primarily by directly boosting their capital rather than through systematic substitution away from assets such as corporate loans, which attract high-risk weights in the calculation of Basle Accord–style capital requirements.

In short, this interpretation of the U.K. evidence makes capital requirements appear to be an attractive regulatory instrument since they serve to reinforce the stability of the banking system without apparently distorting banks' lending choices.

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ENDNOTE

The views expressed in this paper are the authors' and do not necessarily reflect the views of the Bank of England.

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Assessing the Impact of Prompt Corrective Action on Bank Capital and Risk

Raj Aggarwal and Kevin T. Jacques

In December 1991, the U.S. Congress passed the Federal Deposit Insurance Corporation Improvement Act (FDICIA), which emphasized the importance of capital ratios in addressing the problems that led to the large number of bank and thrift failures in the 1980s. In addressing these issues, FDICIA contained two key provisions designed to reduce the cost and frequency of failed banks. First, FDICIA contained a provision for early closure of institutions that allowed bank regulators to close failing institutions at a positive level of capital. Such an early closure policy had been advocated as a solution to excessive losses to the deposit insurance fund, as discussed by Kane (1983). The second key provision of FDICIA, prompt corrective action (PCA), involved early intervention in problem banks by bank regulators. While PCA was intended to supplement the existing supervisory authority of bank regulators, FDICIA legislated mandatory intervention, rather than regulatory discretion, in undercapitalized institutions in an effort to save banks from becoming insolvent.

To date, the PCA provisions of FDICIA appear to have been a major success in improving the safety and soundness of the U.S. banking system. Failures declined precipitously in the years following the passage of FDICIA, while a casual observation of bank capital ratios and levels suggests that PCA has been successful in getting banks to increase capital. From year-end 1991 through year-end 1993, equity capital held by U.S. commercial banks in the aggregate increased by over $65 billion, an increase of 28.0 percent, while the ratio of equity capital to assets increased from 6.75 percent to 8.01 percent.

While the adoption and implementation of PCA has focused attention on bank capital ratios, two issues merit further attention. First, did PCA cause banks to increase their capital ratios, or is the increase attributable to some other factor such as bank income levels in the early 1990s? Second, a number of theoretical and empirical studies suggest that increasingly stringent regulatory capital standards in general, and PCA in particular, may have the unintended effect of causing banks to increase their level of portfolio risk.

This paper examines the impact that the PCA standards had on bank portfolios following the passage of FDICIA in 1991. To do this, the simultaneous equations model developed by Shrieves and Dahl (1992), and later modified by Jacques and Nigro (1997) to study the impact of risk-based capital, is used to examine how PCA simultaneously influenced bank capital ratios and portfolio risk

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levels. Unlike prior studies on this topic, by using a simultaneous equations model, the endogeneity of both capital and portfolio risk is explicitly recognized, and as such, the impact of possible changes in bank capital ratios on risk in a bank's portfolio can be examined.

THE PROMPT CORRECTIVE ACTION STANDARDS

In December 1991, the U.S. Congress passed FDICIA, with the PCA provisions becoming effective in December 1992. Specifically, Section 131 of FDICIA, defined for banks five capital thresholds used to determine what supervisory actions would be taken by bank regulators, with increasingly severe restrictions being applied to banks as their capital ratios declined. As shown in Table 1, banks are classified into one of five capital categories depending on how well they meet capital thresholds based on their total risk-based capital ratio, Tier 1 risk-based capital ratio, and Tier 1 leverage ratio.[1] For example, in order to be classified as well capitalized, a bank must have a total risk-based capital ratio greater than or equal to 10 percent, a Tier 1 risk-based capital ratio greater than or equal to 6 percent, and a Tier 1 leverage ratio greater than 5 percent, while adequately capitalized institutions have minimum thresholds of 8 percent, 4 percent, and 4 percent, respectively. If a bank falls into one of the three undercapitalized categories, mandatory restrictions are placed on its activities that become increasingly severe as the bank's capital ratios deteriorate. For example, undercapitalized banks are subject to restrictions that include the need to submit and implement a capital restoration plan, limits on asset growth, and restrictions on new lines of business, while significantly undercapitalized banks face all of the restrictions imposed on undercapitalized banks, as well as restrictions on interest rates paid on deposits, limits on transactions with affiliates and affiliated banks, and others. Finally, once a bank's tangible equity ratio falls to 2 percent or less, the bank is considered to be critically undercapitalized and faces not only more stringent restrictions on activities, but also the appointment of a conservator (receiver) within ninety days of becoming critically undercapitalized.[2]

Table 1 also shows the breakdown of insured commercial banks by PCA zone over the period 1991-93. For example, at year-end 1991, the time when FDICIA was passed, 10,725 banks, accounting for only 43.3 percent of the total assets in the U.S. banking system, were classified as well capitalized. In contrast, 221, 71, and 96 banks were classified as either undercapitalized, significantly undercapitalized, and critically undercapitalized, respectively. In total, 388 banks with 10.88 percent of all bank assets were undercapitalized to some degree at the end of 1991 and therefore faced at least some degree of regulatory sanction if their capital ratios did not improve by the time PCA went into effect.

By year-end 1992, the period after PCA provisions were announced but before they went into effect, the results in Table 1 show that well-capitalized banks numbered 10,989, accounting for over 87 percent of all bank assets, while all types of undercapitalized banks fell to only 142, thus accounting for less than 1 percent of total bank assets. A similar but less dramatic shift is seen in 1993, the first year the PCA regulations were in effect. By year-end 1993, 96.24 percent of banking assets were in banks classified as well capitalized, while only forty-eight banks were classified in the three undercapitalized zones, and those banks accounted for less than 0.25 percent of all banking

Table 1
CAPITAL THRESHOLDS AND BANK CLASSIFICATION UNDER PROMPT CORRECTIVE ACTION

Capital Threshold	Total Risk-Based Capital	Tier 1 Risk-Based Ratio	Tier 1 Leverage Ratio
Well capitalized	≥10%	≥6%	≥5%
Adequately capitalized	≥8%	≥4%	≥4%
Undercapitalized	<8%	<4%	<4%
Significantly undercapitalized	<6%	<3%	<3%
Critically undercapitalized		Tangible equity ≤ 2%	

NUMBER OF BANKS AND PERCENTAGE OF TOTAL BANK ASSETS BY PCA ZONE

PCA Zone	1991	1992	1993
Well capitalized	10,725	10,989	10,752
	43.30	87.51	96.24
Adequately capitalized	807	335	171
	45.82	11.72	3.51
Undercapitalized	221	67	22
	10.17	0.29	0.11
Significantly undercapitalized	71	33	16
	0.39	0.17	0.12
Critically undercapitalized	96	42	10
	0.32	0.32	0.03

Source: Data are from the Office of the Comptroller of the Currency.

assets. These findings suggest that PCA had a significant announcement effect on bank capital ratios during 1992, as well as a significant implementation effect on capital ratios once the standards were implemented.

While PCA appears to have been effective in getting banks to increase their capital ratios, it has not been without its critics.[3] One criticism that has been levied against regulatory capital standards in general is that they may lead to increasing levels of bank portfolio risk. Research by Kahane (1977), Koehn and Santomero (1980), and Kim and Santomero (1988) has shown, using the mean-variance framework, that regulatory capital standards cause leverage and risk to become substitutes and that as regulators require banks to meet more stringent capital standards, banks respond by choosing assets with greater risk.[4] Thus, increases in minimum capital standards by bank regulators cause banks to increase not only their capital ratios, but also have the unintended effect of causing them to increase their level of risk.

While one of the primary purposes of early closure is to prevent banks from taking increasing levels of risk as they approach insolvency, recent research by Levonian (1991) and Davies and McManus (1991) demonstrates that early closure may fail to protect the deposit insurance fund from losses because it creates incentives for banks to increase portfolio risk by increasing their holdings of high-risk assets. As such, the design of the PCA standards has important implications not only for capital levels, but also for the level of risk, and ultimately, the safety and soundness of the banking system.

Model Specification

To examine the possible impact of the PCA standards on bank capital ratios and portfolio risk levels, the simultaneous equation model developed by Shrieves and Dahl (1992) is modified to incorporate the PCA zones. In their model, observed changes in bank capital ratios and portfolio risk levels are decomposed into two components, a discretionary adjustment and a change caused by an exogenously determined random shock such that:

(1) $$\Delta CAP_{j,t} = \Delta^{d} CAP_{j,t} + E_{j,t} ;$$

(2) $$\Delta RISK_{j,t} = \Delta^{d} RISK_{j,t} + U_{j,t} ,$$

where $\Delta CAP_{j,t}$ and $\Delta RISK_{j,t}$ are the observed changes in capital ratios and risk levels for bank j in period t, $\Delta^{d} CAP_{j,t}$ and $\Delta^{d} RISK_{j,t}$ represent the discretionary adjustments in capital ratios and risk levels, and $E_{j,t}$ and $U_{j,t}$ are exogenous shocks. Recognizing that banks may not be able to adjust to their desired capital ratios and risk levels instantaneously, the discretionary changes in capital and risk are modeled using the partial adjustment framework. As a result:

(3) $$\Delta CAP_{j,t} = \alpha (CAP^{*}_{j,t} - CAP_{j,t-1}) + E_{j,t} ;$$

(4) $$\Delta RISK_{j,t} = \beta (RISK^{*}_{j,t} - RISK_{j,t-1}) + U_{j,t} .$$

Thus, the observed changes in bank capital ratios and portfolio risk levels in period t are a function of the target capital ratio $CAP^{*}_{j,t}$ and target risk level $\Delta RISK^{*}_{j,t}$, the lagged capital ratio CAP_{t-1} and risk levels $RISK_{t-1}$, and any random shocks. The target capital ratio and risk level are not observable, but are assumed to depend upon some set of observable variables including the size of the bank (*SIZE*), multibank holding company status (*BHC*), a bank's income (*INC*), changes in portfolio risk $(\Delta RISK_{j,t})$, and capital ratios $(\Delta CAP_{j,t})$, while the exogenous shock that could affect bank capital ratios or risk levels is the regulatory pressure brought about by PCA.

Specifically, *SIZE* is measured as the natural log of total assets and *BHC* is a dummy variable equal to 1 if a bank is affiliated with a multibank holding company. As Shrieves and Dahl (1992) note, size may have an impact on a bank's capital ratios and level of portfolio risk because larger banks have greater access to capital markets. For banks belonging to multibank holding companies, both capital and portfolio risk may be managed at the holding company level, thus resulting in these banks having lower target capital ratios and higher target portfolio risk levels than independent banks. Following Jacques and Nigro (1997), the ratio of net income to total assets, *INC*, is included to recognize the ability of profitable banks to increase their capital ratios by using retained earnings. In addition, as noted by the use of the partial adjustment model, lagged capital ratios and risk levels are included to measure the fact that banks adjust their capital ratios and risk levels to their target levels over time.

To recognize the possible simultaneous relationship between capital and risk, $\Delta CAP_{j,t}$ and $\Delta RISK_{j,t}$ are included in the risk and capital equations, respectively. Shrieves and Dahl (1992) note that a positive relationship between changes in capital and risk may signify, among other possibilities, the unintended impact of minimum regulatory capital requirements, while Jacques and Nigro (1997) note that a negative relationship may result because of methodological flaws in the capital standards underlying PCA.[5] Empirical estimation of the simultaneous equations model requires measures of both bank capital ratios and portfolio risk. Following previous research, portfolio risk was measured in two ways, using both the total risk-weighted assets as a percentage of total assets (*RWARAT*) and nonperforming loans as a percentage of total assets (*NONP*).[6] Avery and Berger (1991) have shown that *RWARAT* correlates with risky behavior, while other studies, such as those by Berger (1995) and Shrieves and Dahl (1992), use nonperforming loans. With respect to capital, the leverage ratio is used because Baer and McElravey (1992) find it was more binding than the risk-based capital standards during the period under study.

Of particular interest in this study is the regulatory pressure variables. Consistent with Shrieves and Dahl (1992), this study uses dummy variables to signify the degree of regulatory pressure that a bank is under. Specifically, the PCA dummies are:

$PCAA$ = 1 if the bank is adequately capitalized; else = 0.

$PCAU$ = 1 if the bank is undercapitalized, substantially undercapitalized, or critically undercapitalized (hereafter referred to as undercapitalized); else = 0.

These variables allow banks across different PCA zones to respond differently, both in capital ratios and in portfolio risk. A priori, banks in the undercapitalized group, $PCAU$, would be expected to have the strongest response because PCA imposes penalties on their activities. Furthermore, adequately capitalized banks, $PCAA$, may increase their capital ratios or reduce their portfolio risk if they perceive a significant penalty for not being considered well capitalized, or if they desire to hold a buffer stock of capital as a cushion against shocks to equity as argued by Wall and Peterson (1987, 1995) and Furlong (1992). Besides being included as a separate variable, PCA is included in an interaction term with the lagged capital ratios. The use of this term allows banks in different PCA zones to have different speeds of adjustment to their target capital ratios. As such, banks in the undercapitalized PCA zones would be expected to adjust their capital ratios at faster rates than better capitalized banks.

Given these variables, equations 3 and 4 can be written:

$$(5)\ \Delta CAP_{j,t} = \delta_0 + \delta_1 SIZE_{j,t} + \delta_2 BHC_{j,t} + \delta_3 INC_{j,t} + \delta_4 \Delta RISK_{j,t} + \delta_5 PCAA + \delta_6 PCAU - \delta_7 CAP_{j,t-1} - \delta_8 PCAA \times CAP_{j,t-1} - \delta_9 PCAU \times CAP_{j,t-1} + \mu_{j,t}\ ;$$

$$(6)\ \Delta RISK_{j,t} = \lambda_0 + \lambda_1 SIZE_{j,t} + \lambda_2 BHC_{j,t} + \lambda_3 \Delta CAP_{j,t} + \lambda_4 RISK_{j,t-1} + \lambda_5 PCAA + \lambda_6 PCAU + \omega_{j,t}\ ,$$

where $\mu_{j,t}$ and $\omega_{j,t}$ are error terms, and $PCAA \times CAP_{j,t-1}$ and $PCAU \times CAP_{j,t-1}$ are interaction terms, which allow a bank's speed of adjustment to be influenced by the PCA zone the bank is in.

EMPIRICAL ESTIMATION

As noted earlier, the FDICIA was passed in December 1991, with the PCA thresholds becoming effective in December 1992. This study covers the period after passage but before implementation (1992), and the first year the PCA standards were in effect (1993). In addition, because all of the capital ratios used in PCA are available beginning at the end of 1990, 1991 is used as a control period. As noted earlier, a significant decline in the number of all types of undercapitalized institutions occurred during the year after FDICIA was passed. This result is not surprising because restrictions would be placed on the activities of these banks beginning in December 1992. Alternatively, in studying the impact of the risk-based capital standards, Haubrich and Wachtel (1993) note that because the composition of bank portfolios can be changed quickly, and because banks appear to have experienced a period of learning, the impact appears more clearly after the implementation date. The same argument may be true for PCA, although learning by banks may be less significant with regard to PCA because all of the capital ratios defined in the PCA standards had been in effect since at least December 1990.[7]

RESULTS

This study examines 2,552 FDIC-insured commercial banks with assets of $100 million or more using year-end call report data from 1990 through 1993.[8] The model is estimated using the two-stage least squares procedure, which recognizes the endogeneity of both bank capital ratios and risk levels in a simultaneous equation framework, and unlike ordinary least squares, provides consistent parameter estimates.

The results of estimating the simultaneous system of equations 5 and 6 are presented in Tables 2 and 3. Table 2 uses the ratio of risk-weighted assets to total assets (*RWARAT*) to measure portfolio risk, while Table 3 measures risk using nonperforming loans as a percentage of total assets (*NONP*). All of the variables included to explain variations in capital ratios and risk levels are statistically significant in at least some of the equations. Bank size (*SIZE*) had a negative and significant impact on capital ratios in two equations, while multibank holding company status (*BHC*) was consistently negative and significant in the capital equations. Income (*INC*) had a positive and significant impact on capital ratios in all equations, suggesting that one reason for increasing capital ratios by banks over the period studied was the increase in their income levels. The parameter estimates on lagged risk $(RISK_{j,t-1})$ in the risk equations range from 5.3 percent to 24.7 percent, while the parameter estimates on lagged capital $(CAP_{j,t-1})$ in the capital equations range from 6.2 percent to 8.9 percent. These results imply that banks

Table 2
TWO-STAGE LEAST SQUARES ESTIMATES OF PROMPT CORRECTIVE ACTION ON RISK (RWARAT) AND CAPITAL

	1991		1992		1993	
Variable	ΔCAP	ΔRISK	ΔCAP	ΔRISK	ΔCAP	ΔRISK
INTERCEPT	0.005*	0.021*	0.005*	0.029*	0.007*	0.032*
	(7.57)	(2.89)	(6.77)	(6.33)	(8.46)	(7.62)
SIZE	-0.000	0.001**	0.000	-0.000	0.000	-0.000*
	(-1.27)	(1.71)	(0.66)	(-0.92)	(1.09)	(-1.97)
BHC	-0.001*	0.015*	-0.002*	0.004*	-0.003*	0.008*
	(-3.83)	(5.33)	(-5.64)	(2.48)	(-7.51)	(4.64)
INC	0.387*	—	0.551*	—	0.409*	—
	(20.32)		(26.47)		(14.71)	
CAP_{t-1}	-0.070*	—	-0.089*	—	-0.062*	—
	(-9.47)		(-11.39)		(-7.31)	
$RISK_{t-1}$	—	-0.144*	—	-0.069*	—	-0.053*
		(-13.11)		(-8.99)		(-7.74)
ΔCAP	—	1.351*	—	0.284*	—	0.552*
		(8.14)		(2.74)		(3.20)
ΔRISK	0.017*	—	0.014*	—	0.042*	—
	(5.47)		(4.24)		(2.61)	
PCAA	0.009*	0.037*	0.022*	-0.015*	0.027*	-0.024*
	(2.98)	(9.25)	(6.10)	(-4.32)	(3.72)	(-4.78)
PCAU	0.023*	0.037*	0.039*	-0.016*	0.024*	-0.037*
	(8.05)	(5.01)	(9.70)	(-2.40)	(3.17)	(-3.97)
PCAA × CAP_{t-1}	-0.135*	—	-0.301*	—	-0.389*	—
	(-2.92)		(-4.91)		(-3.19)	
PCAU × CAP_{t-1}	-0.319*	—	-0.627*	—	-0.129	—
	(-5.17)		(-6.75)		(-0.68)	
R^2	.218	.123	.271	.063	.146	.060

Note: *t*-statistics appear in parentheses.

* Significant at the 5 percent level.

** Significant at the 10 percent level.

adjusted their capital ratios and risk positions very slowly over this period to their target levels. Finally, Tables 2 and 3 show mixed results in assessing the relationship between changes in capital ratios and changes in risk. When portfolio risk was measured using *NONP*, the changes in capital ratios and risk were negatively correlated, but when portfolio risk was measured using *RWARAT*, the parameter estimates were positive. Thus, the relationship between changes in capital ratios and changes in risk during this period is not unambiguous. The goal of this study is to clarify this relationship by examining the possible simultaneous impact of the PCA standards on both bank capital ratios and risk levels.

Impact of PCA on Capital

In examining the impact of PCA, the results in Tables 2 and 3 provide some rather interesting insights. In the capital equations of each table, the impact of the regulatory pressure variables are captured both by an intercept term (*PCAA* or *PCAU*) and a speed of adjustment term ($PCAA \times CAP_{t-1}$ or $PCAU \times CAP_{t-1}$). For adequately capitalized banks (*PCAA*), regulatory pressure had a positive impact on capital ratios in both 1992 and 1993, with the parameter estimate in most cases being at least 100 percent larger in 1992 and 1993 than in 1991. Furthermore, the speed of adjustment terms for adequately capitalized banks are statistically significant, being in most cases two to four times greater in 1992 and 1993 than in 1991. Taken together, these results suggest that in both 1992 and 1993, banks classified as being adequately capitalized increased their capital ratios and the speed with which they adjusted their capital ratios in response to PCA. Furthermore, this result is consistent with the hypothesis that banks held capital above the regulatory minimum as a buffer against shocks that could cause their capital ratios to fall below the adequately capitalized thresholds.

Table 3
Two-Stage Least Squares Estimates of Prompt Corrective Action on Risk (NONP) and Capital

	1991		1992		1993	
Variable	ΔCAP	ΔRISK	ΔCAP	ΔRISK	ΔCAP	ΔRISK
INTERCEPT	0.004*	0.001*	0.004*	0.001*	0.004*	0.000**
	(5.42)	(5.71)	(5.38)	(4.43)	(3.90)	(1.71)
SIZE	-0.000**	0.000	-0.000**	-0.000*	-0.000	-0.000
	(-1.67)	(0.38)	(-1.71)	(-4.07)	(-1.07)	(-0.23)
BHC	-0.001*	-0.001*	-0.002*	-0.001*	-0.003*	-0.000
	(-4.03)	(-2.55)	(-6.35)	(-3.11)	(-6.56)	(-1.07)
INC	0.436*	—	0.578*	—	0.594*	—
	(20.14)		(25.70)		(14.98)	
CAP_{t-1}	-0.078*	—	-0.089*	—	-0.086*	—
	(-10.14)		(-10.66)		(-8.62)	
$RISK_{t-1}$	—	-0.247*	—	-0.171*	—	-0.228*
		(-18.31)		(-11.78)		(-17.62)
ΔCAP	—	-0.011	—	-0.058*	—	0.076*
		(-0.61)		(-3.52)		(3.00)
ΔRISK	-0.295*	—	-0.476*	—	-0.957*	—
	(-5.43)		(-9.43)		(-6.43)	
PCAA	0.011*	0.000	0.015*	0.003*	0.036*	-0.000
	(3.55)	(1.11)	(3.67)	(4.84)	(4.14)	(-0.20)
PCAU	0.021*	-0.000	0.028*	0.000	0.034*	-0.006*
	(7.19)	(-0.37)	(6.35)	(0.35)	(3.67)	(-4.57)
$PCAA \times CAP_{t-1}$	-0.165*	—	-0.166*	—	-0.599*	—
	(-3.42)		(-2.47)		(-4.05)	
$PCAU \times CAP_{t-1}$	-0.302*	—	-0.414*	—	-0.601*	—
	(-4.66)		(-4.06)		(-2.52)	
R^2	.194	.134	.261	.078	.119	.144

Note: *t*-statistics appear in parentheses.

* Significant at the 5 percent level.

** Significant at the 10 percent level.

The same results appear to hold true for undercapitalized banks (*PCAU*), although the timing and magnitude of the changes appear somewhat different. The parameter estimates on *PCAU* are significantly different from zero in both 1992 and 1993, and in all cases, they are larger than during the control period. In addition, the speed of adjustment estimates are generally significant and of greater magnitude than during the control period, thereby suggesting that undercapitalized banks adjusted their capital ratios at much faster rates than their well-capitalized counterparts. Examining the results in Table 2, the parameter estimates on *PCAU* and $PCAU \times CAP_{t-1}$ for 1992 are almost twice as large as the estimates for the control period, while the 1993 estimates are similar in magnitude or not significant. These results are not surprising because banks that were classified in one of the three undercapitalized zones at the end of 1991 faced regulatory sanctions if they did not significantly increase their capital ratios by the time the PCA standards went into effect in December 1992.

It is also interesting to compare the parameter estimates on *PCAU* and *PCAA* in the capital equations. In general, the estimates on *PCAU* and $PCAU \times CAP_{t-1}$ are larger than similar estimates for adequately capitalized banks in 1992, but not in 1993. This result is also not surprising because undercapitalized banks faced severe restrictions on their activities once PCA went into effect, while adequately capitalized banks did not.

Impact of PCA on Risk

With respect to portfolio risk, the results in Tables 2 and 3 provide some evidence that the regulatory pressure brought about by PCA led both adequately capitalized and undercapitalized banks to decrease their level of portfolio risk. While the results with respect to risk in Table 3 are generally insignificant, when portfolio risk is measured using *RWARAT* (Table 2), the results suggest that adequately capitalized banks (*PCAA*) significantly decreased their portfolio risk in both 1992 and 1993, with the parameter estimate for 1993 being 60 percent larger than the estimate for 1992. In a similar manner, the parameter estimates for undercapitalized banks (*PCAU*) in Table 2 are negative and significant in both 1992 and 1993, with the parameter estimate for 1993 being more than twice as large as the 1992 estimate. This is in sharp contrast to the results for 1991, where the parameter estimates for both adequately capitalized and undercapitalized banks are positive and significant, thus suggesting that these banks were increasing portfolio risk in the period before *FDICIA* was passed. For 1992 and 1993, the reduction in risk is not surprising because while PCA was announced in December 1991, sanctions and restrictions on banks became effective at the end of 1992. Therefore, if banks viewed the sanctions associated with PCA as being costly, they had a greater incentive once PCA became effective to reduce their portfolio risk level, and thereby reduce the probability of falling below the capital thresholds due to shocks to equity or income.

Finally, the 1992 parameter estimate on *PCAU* in Table 2 is almost identical to that on *PCAA*, a result that suggests that while both types of banks responded to the announcement of PCA by reducing risk, the reduction in risk by undercapitalized banks was not significantly different from that of adequately capitalized institutions. Given the results of the capital equations in Table 2 that undercapitalized banks had larger adjustments to their capital ratios in 1992 than in 1993, and recognizing that undercapitalized banks may be able to adjust their risk levels faster than they can adjust their capital ratios, it is possible that undercapitalized banks emphasized increasing capital rather than reducing risk in 1992. However, in 1993, the parameter estimate on *PCAU* in the risk equation of Table 2 is over 50 percent greater than the parameter estimate on *PCAA*. This provides some evidence that undercapitalized banks may have felt even greater pressure than adequately capitalized banks to reduce their level of portfolio risk once the PCA standards became effective.

Conclusion

The purpose of this paper has been to investigate the impact of the PCA standards on bank capital ratios and portfolio risk levels. The results suggest that during both 1992 and 1993, adequately capitalized and undercapitalized banks increased their capital ratios and the rate at which they adjusted their capital ratios in response to the PCA standards. In addition, this study finds some evidence that the PCA standards led to significant reductions in portfolio risk, particularly in 1993, the year after PCA took effect. While these results do not guarantee that bank capital levels are adequate relative to the risk in bank portfolios, they do suggest that PCA has been effective in getting banks to simultaneously increase their capital ratios and reduce their level of portfolio risk.

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ENDNOTES

1. In addition, FDICIA authorizes bank regulators to reclassify a bank at a lower capital category if, in the opinion of the bank regulators, the bank is operating in an unsafe or unsound manner.

2. The tangible equity ratio equals the total of Tier 1 capital plus cumulative preferred stock and related surplus less intangibles except qualifying purchased-mortgage-servicing rights divided by the total of bank assets less intangible assets except qualifying purchased-mortgage-servicing rights.

3. For example, see Peek and Rosengren (1996, 1997).

4. The mean-variance framework has been criticized by some because it fails to incorporate the effects of deposit insurance. See Furlong and Keeley (1989) and Keeley and Furlong (1990).

5. Shrieves and Dahl (1992) note that a positive relationship between changes in capital ratios and portfolio risk may also occur because of regulatory costs, bankruptcy cost avoidance, and managerial risk aversion.

6. Because loans made in a given year will not be recognized as nonperforming until a future period, we follow Shrieves and Dahl (1992) and use nonperforming loans in the following year. Thus, the *N0NP* variable is the ratio of nonperforming loans to total assets from year-end 1992 through 1994.

7. Finally, a word of caution is necessary because this analysis may be complicated by other factors present during this time period, such as the end of the interim period for implementation of the risk-based capital standards and other provisions of FDICIA, all of which make it difficult to isolate and definitively assess the impact of the PCA provisions. Nevertheless, with the simultaneous assessment of changes in bank capital, portfolio risk, and the regulatory environment, this study is a significant improvement over our prior understanding of the impact of FDICIA, in general, and PCA, in particular.

8. As noted in endnote 6, because of the nature of nonperforming loans, *N0NP* was calculated using year-end data from 1992 through 1994.

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Fair Value Accounting and Regulatory Capital Requirements

Tatsuya Yonetani and Yuko Katsuo

1. Introduction

Advocates of fair value accounting believe that fair values provide more relevant measures of assets, liabilities, and earnings than do historical costs. These advocates assert that fair value accounting better reflects underlying economic values. The advantages of this method—and the corresponding weaknesses of historical cost accounting—are described in more detail in "Accounting for Financial Assets and Financial Liabilities," a discussion paper published by the International Accounting Standards Committee (IASC) in March 1997. The IASC requires that all assets and liabilities be recognized at fair value. Under fair value accounting, changes in fair values (that is, unrealized holding gains and losses) are recognized in current earnings. In contrast, under historical cost accounting, changes in fair values are not recognized until realized.

Even though the fair value accounting debate relates to all entities and all assets and liabilities, the focus has been on banks' securities. In the United States, the Financial Accounting Standards Board (FASB) issued Statement of Financial Accounting Standards No. 115, "Accounting for Certain Investments in Debt and Equity Securities," in May 1993. The FASB intended this standard to encourage banks to recognize at fair value more investment securities than before. In Japan, fair value accounting was introduced for the trading accounts of banks' securities in April 1997, but investment accounts for banks' securities have not yet been recognized at fair value. The concept of fair value accounting has also been partly adopted in regulatory capital requirements based on the 1988 Basle Accord. In this framework, unrealized profits of investment securities can be included only in the numerator of the capital-to-assets ratio used to assess capital adequacy.

However, some fair value accounting critics are concerned that the precipitous adoption of market value accounting will have adverse effects on both banks and the financial system as a whole. In particular, these critics believe that earnings based on fair values for investment securities are likely to be more volatile than those based on historical cost. They assert that this increased volatility does not reflect the underlying economic volatility of banks' operations and that investors will demand an excessive premium, therefore causing investors to allocate funds inefficiently.

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Critics also assert that using fair value accounting for investment securities is likely to cause banks to violate regulatory capital requirements more often than is economically appropriate, resulting in excessive regulatory intervention or in costly actions to reduce the risk of regulatory intervention. Actually, regulatory capital requirements based on the 1988 Basle Accord may have strongly influenced Japanese banks' lending behavior after the bubble period. Following that period, Japanese banks experienced a sharp reduction in unrealized gains from equities. This may have led banks to adopt overly cautious lending behaviors to reduce the risk of regulatory intervention.

Using data on U.S. banks, Barth, Landsman, and Wahlen (1995) have investigated the empirical validity of the above-mentioned concerns about fair value accounting. They found no convincing evidence to justify these concerns. Specifically, Barth, Landsman, and Wahlen found:

- Fair-value-based earnings are more volatile than historical cost earnings, but share prices do not reflect the incremental volatility.
- Banks violate regulatory capital requirements more frequently under fair value than under historical cost accounting.
- Fair-value-based violations help predict actual regulatory capital violations, but share prices do not reflect this potential increase in regulatory risk.

In this paper, we describe an empirical study of fair value accounting, applying to data on Japanese banks the analytical methods of Barth, Landsman, and Wahlen. We also discuss a further study of regulatory risk in capital requirements associated with fair value accounting, focusing on banks with low Basle capital adequacy ratios. This is a different approach from that of Barth, Landsman, and Wahlen. In the United States, these authors calculated capital ratios on a fair value accounting basis with unrealized securities profits. Using these figures, they tested how fair-value-based violations help predict actual regulatory capital violations and to what extent investors recognize this potential increased regulatory risk. In this paper, we investigate, using actual Basle adequacy ratios, the regulatory risk in capital requirements associated with fair value accounting. The outline of our study is as follows:

- We examine how fair value accounting affects earnings volatility and whether any incremental volatility is reflected in bank share prices. If this is the case, do investors view fair value earnings volatility as a better proxy for economic risk than historical cost earnings volatility?
- We examine the effect of fair value accounting on the volatility of regulatory capital ratios and whether any increase in regulatory risk associated with fair value accounting is reflected in share prices. (Regulatory risk is one component of banks' total economic risk.) We specifically focus on banks with low Basle capital adequacy ratios, examining how far the incremental volatility associated with fair value accounting is reflected in bank share prices.
- We seek a better formula for Basle capital adequacy ratios, using the concept of fair value accounting. Specifically, we compare the volatility of capital adequacy ratios, using the current Basle Accord formula (only capitals are calculated using the unrealized gains of investment securities), the formula using historical cost accounting, and the fair value formula (in which both capitals and assets are calculated using the unrealized gains of investment securities).

We find that:

- Bank earnings based on the fair values of investment securities are significantly more volatile than earnings based on historical cost securities gains and losses.
- However, the assertion that investors generally demand an excessive premium because of the increased volatility associated with fair value accounting, thereby raising banks' cost of capital, is not supported by any strong empirical evidence.
- On those critical occasions, when investors value low-capital-ratio banks' shares, the volatility in fair value earnings incremental to that in historical cost earnings is also priced as risk. The choice of accounting formula adopted in regulatory capital requirements is therefore very important.
- The Basle capital adequacy formula adopts (somewhat) the concept of fair value accounting because the formula allows the inclusion of unrealized gains of investment securities in the calculation of capital (the numerator). However, when including such

unrealized gains, they should also be used in the calculation of assets (the denominator). From the practical point of view, this assertion is also supported by the fact that the fair value formula (both capital and assets are calculated using the unrealized gains of investment securities) is less volatile than the current formula.

The remainder of this paper is organized as follows: section 2 describes our data and sample banks. sections 3 and 4 present our empirical findings related to earnings volatility and regulatory risk associated with fair value accounting. In section 5, we seek a better formula for Basle Accord capital adequacy ratios using fair value accounting. Section 6 concludes our discussion.

2. Data and Sample Banks

The sample comprises annual data from fiscal year (FY) 1989-FY1996 for eighty-seven Japanese banks that more than once during this period adopted capital adequacy ratios based on the 1988 Basle Accord. Our estimation includes banks that, because of their fragile financial condition, have adopted Basle capital adequacy ratios only during a limited period. However, banks that defaulted during the period are excluded (even though these banks' property has been handed over to other banks).

We focus in this study on listed investment securities, because only unrealized gains for listed securities are calculated in capital adequacy ratios based on the 1988 Basle Accord.[1] These estimates are obtained from annual statements of accounts. We can estimate annual fair value profits and losses of investment securities during the FY1989-FY1996 period, using data from annual statements of accounts in which unrealized gains and losses for listed securities data are disclosed since FY1990 and unrealized securities gains calculated in Basle Accord capital adequacy ratios are disclosed since FY1989.

3. Earnings Volatility

Here we address two specific questions:

- Are earnings more volatile using fair value accounting for investments rather than using historical cost?
- If earnings are more volatile, do investors perceive this increased volatility as an additional risk premium and do banks' share prices reflect such a premium?

This will be the case if volatility in earnings based on fair values for investment securities is a better proxy for economic risk than that based on historical cost.

3.1. Empirical Measures of Earnings Volatility

Table 1 presents cross-sectional descriptive statistics of earnings under historical cost and fair value accounting and realized and unrealized securities gains and losses using a sample of eighty-seven Japanese banks over the 1989-96 period. The four earnings variables are historical cost earnings (HCE—that is, ordinary income), HCE plus unrealized annual gains and losses for investment securities (that is, fair value earnings, or FVE), realized securities gains and losses (RSGL), and unrealized securities gains and losses (URSGL). Realized investment securities gains and losses are recognized under historical cost accounting. Under fair value accounting, banks recognize as investment securities gains and losses that are the sum of RSGL and URSGL.[2]

Obviously, URSGL is more volatile than RSGL. The effect of unrealized securities gains and losses on ordinary income in any given year can be large. Table 1 shows the standard deviations over the 1989-96 period, measured for the cross-sectional mean in fair value earnings

Table 1
Descriptive Statistics: Earnings Variables

		HCE		FVE		RSGL		URSGL	
Year	N	Mean	σ	Mean	σ	Mean	σ	Mean	σ
89	87	105.1	157.8	-207.1	333.0	25.5	62.3	-312.2	457.7
90	87	97.5	146.3	-104.5	238.3	43.1	101.5	-202.0	332.6
91	87	82.5	124.6	-212.9	565.9	0.4	43.6	-295.3	623.4
92	87	83.9	133.2	107.6	320.4	5.7	54.1	23.7	261.3
93	87	67.8	116.6	146.1	226.5	30.1	70.0	78.3	143.7
94	87	74.9	144.8	-129.4	315.8	16.2	98.8	-204.3	333.0
95	87	26.0	156.0	197.1	360.3	86.2	161.0	171.2	250.1
96	87	26.2	203.0	-171.6	448.0	4.4	80.0	-197.8	365.2
Mean		70.5		-46.8		26.5		-117.3	
σ of Mean N=8		29.8		168.8		28.2		182.2	

Note: σ denotes standard deviation.

and in historical cost earnings. The former (σ of mean: 168.8) is more than five times greater than the latter (σ of mean: 29.8).

3.2. Earnings Variability and Share Prices

The increased earnings volatility associated with fair value accounting for investment securities documented in Table 1 raises the question: Does the market perceive this increased volatility as additional risk?

To address this question, we estimate the following relationship:

$$(1) \quad P = \alpha_0 + \alpha_1 PREE_{it} + \alpha_2(\sigma_{HCit} \times PREE_{it}) + \alpha_3[(\sigma_{FVit} - \sigma_{HCit}) \times PREE_{it}] + \varepsilon_{it}(A),$$

where P is the bank's end-of-fiscal-year share price,[3] $PREE$ is earnings per share before securities gains and losses, and i and t represent banks and years, respectively. σ_{HCit} and σ_{FVit} are the standard deviations of historical cost and fair value earnings per share for each bank measured over the recent four years. Because σ_{HC} and σ_{FV} are computed using four years of data, this analysis extends only from FY1992 through FY1996.[4]

However, this estimation period covers the entire duration of the Basle capital adequacy ratios, excluding the trial period. Using this estimation, we can investigate the regulatory risk associated with fair value accounting in accordance with the Basle Accord of 1988. We deal with this in section 4. Equation 1 is based on a valuation model where price is determined as earnings divided by the cost of equity capital. The model assumes that a firm's equity value equals an earnings multiple times permanent earnings, where risk is one of many determinants of the earnings multiple. The earnings multiple is assumed to be negatively related to risk (see appendix).

Equation 1 permits the coefficient on earnings to vary with two risk proxies based on earnings variability. If historical cost accounting earnings and their variance are good proxies for permanent earnings and risk, then the expected sign of α_2 is negative. Because we are trying to determine whether the market perceives the variance associated with fair value accounting as risk incremental to historical cost earnings variance, our test is whether α_3 equals zero. Finding that α_3 is significantly different from zero is consistent with any difference between fair value and historical cost earnings variance being perceived by the market as risk.

Note that the sign of α_3 depends on the sign of the difference between σ_{HC} and σ_{FV}. Because Table 1 reports that the variance of fair value earnings, σ_{FV}, exceeds the variance of historical cost earnings, σ_{HC}, we expect the sign of α_3 to be negative. To be consistent with the going-concern assumption in the underlying valuation model, we eliminate observations with negative earnings, $PREE$.

Table 2 presents regression estimates (N=302) using a fixed-effects estimation of eighty-seven banks. It describes estimations of three fixed-effects models that pool observations across years (FY1992-FY1996). Panel A contains the regression summary statistics for equation 1. Panels B and C present regression summary statistics from estimating versions of equation 1 that include either the volatility of historical cost earnings or fair value earnings, each interacting with earnings before securities gains and losses, but not both.

Panel A indicates that volatility in fair value earnings is not associated with a reduced earnings multiple assigned by investors. The coefficient on $(\sigma_{FVit} - \sigma_{HCit}) \times PREE_{it}$, α_3, is insignificantly different from zero (t = 0.40), indicating that the volatility in fair value earnings incremental to that in historical cost earnings is not priced as risk.

The findings in Panel A are inconsistent with fair value accounting critics' assertions that increased volatility associated with fair value earnings directly affects investors' capital allocation decisions. The findings are consistent with investors who perceive that volatility in historical cost earnings is a better measure of economic risk than volatility in fair value earnings. The fact that bank share prices do not reflect the incremental volatility of fair value earnings is consistent with the findings using U.S. bank data over the 1976-90 period in Barth, Landsman, and Wahlen (1995).

To eliminate collinearity between the two volatility measures, we also estimate each measure alone. Panels B and C indicate that each measure has a significant dampening

Table 2
REGRESSION ESTIMATES FROM FIXED-EFFECTS ESTIMATION

Panel A

$$P_{it} = \alpha_{0i} + \alpha_{0t} + \alpha_1 PREE_{it} + \alpha_2(\sigma_{HCit} \times PREE_{it}) + \alpha_3(\sigma_{FVit} - \sigma_{HCit}) \times PREE_{it} + \varepsilon_{it}$$

Coefficient estimates: $\alpha_1 = 1.40(t = 3.55)$

$\alpha_2 = -0.01(t = -4.13)$ F-test: F (82,216) = 78.646, P-value = [.0000]

$\alpha_3 = 0.0002(t = 0.40)$ Hausman-test: CHISQ(3) = 155.28, P-value = [.0000]

Panel B

$$P_{it} = \alpha_{0i} + \alpha_{0t} + \alpha_1 PREE_{it} + \alpha_2(\sigma_{HCit} \times PREE_{it}) + \varepsilon_{it}$$

Coefficient estimates: $\alpha_1 = 1.47(t = 4.11)$ F-test: F (82,217) = 87.120, P-value = [.0000]

$\alpha_2 = -0.01(t = -4.47)$ Hausman-test: CHSQ(2) = 107.33, P-value = [.0000]

Panel C

$$P_{it} = \alpha_{0i} + \alpha_{0t} + \alpha_1 PREE_{it} + \alpha_2(\sigma_{FVit} \times PREE_{it}) + \varepsilon_{it}$$

Coefficient estimates: $\alpha_1 = 1.07(t = 2.69)$ F-test: F (82,217) = 74.363, P-value = [.0000]

$\alpha_2 = -0.0007(t = -2.07)$ Hausman-test: CHISQ(2) = 145.78, P-value = [.0000]

Notes: P is price per share; *PREE* is earnings per share before securities gains and losses; σ_{HC} is the standard deviation of historical cost earnings per share for each bank measured over the most recent four years; σ_{FV} is the standard deviation of fair value earnings per share, calculated as historical cost earnings plus unrealized gains and losses for investment securities for each bank measured over the most recent four years; i is bank i; t is year t.

effect on the earnings multiple. The coefficients representing the effect of historical cost earnings volatility and fair value earnings volatility on the earnings multiple are significantly negative, with t-statistics of -4.47 and -2.07, respectively. Both volatility measures are therefore proxies for risk. But our findings in Panel A indicate that historical cost volatility dominates fair value earnings volatility as a risk proxy.

4. REGULATORY RISK

4.1. A COMPARISON OF REGULATORY CAPITAL MEASURES

Based on the findings in Table 1, we expect regulatory capital ratios based on fair value accounting to be more volatile than those based on historical cost. This may also be true of Basle adequacy ratios, which, in part, adopt the concept of fair value accounting for investment securities. Table 3 shows a comparison of volatility between current Basle capital adequacy ratios and capital adequacy ratios calculated without unrealized profits for investment securities. Obviously, the former is more volatile than the latter. In the table, the mean of the mean (μ) and the standard deviation (σ) are measured for each bank over the period FY1989-FY1996 using three formulas. These formulas are: current Basle capital adequacy ratios (only capital is

Table 3
COMPARISON OF VOLATILITY OF CAPITAL ADEQUACY RATIOS

	BIS-R	HC-R	FV-R
μ	9.17	7.33	8.81
σ	3.14	2.62	3.02

Notes:

BIS-R is the mean of the mean and the standard deviation measured for each bank over the period FY1989-FY1996, using current Basle capital adequacy ratios (only capital is calculated with unrealized gains of investment securities).

HC-R is the mean of the mean and the standard deviation measured for each bank over the period FY1989-FY1996, using capital ratios based on historical cost accounting.

FV-R is the mean of the mean and the standard deviation measured for each bank over the period FY1989-FY1996, using capital ratios based on fair value accounting (both capital and assets are calculated with unrealized gains of investment securities).

calculated with unrealized gains from investment securities), capital ratios based on historical cost accounting, and capital ratios based on fair value accounting (both capital and assets are calculated with unrealized gains of investment securities). The table uses a sample of eighty-seven Japanese banks over the period FY1989-FY1996. Actually, in Japan the current Basle capital adequacy formula is sometimes criticized because the inclusion of unrealized gains of investment securities in capital (the numerator) intensifies the volatility of capital adequacy ratios, thus having an inappropriate impact on bank behavior.

4.2. Regulatory Risk and Share Prices

Now we investigate the pricing effect of regulatory risk by estimating equation 1 for banks with low Basle capital adequacy ratios. Banks with low Basle capital adequacy ratios may have a greater possibility of regulatory capital violations caused by the volatility of unrealized profits for investment securities than do banks with high capital adequacy ratios. If so, fair value earnings volatility is most likely to be priced incrementally to historical cost earnings volatility for banks with low Basle capital adequacy ratios. If the fair value earnings volatility of banks with low capital adequacy ratios is reflected in their share prices, investors should recognize the regulatory risk associated with fair value accounting.

Table 4 presents Basle capital adequacy ratio levels and the number of banks having those levels. We focus on banks with low capital adequacy ratios (under 9.0 percent). Table 5 provides estimates of the relationships between bank share prices and earnings before securities gains and losses, volatility in reported earnings, and volatility in fair value earnings. Regression estimates are from fixed-effects estimation. The sample represents Japanese banks with low capital adequacy ratios (under 9.0 percent) during the 1992-96 period. The table reveals that the coefficients' effects on the earnings multiple are significantly negative (with *t*-statistics of -3.01 and -3.37), even though the historical cost earnings coefficient is larger than that of the fair value earnings coefficient. So, for banks with low capital adequacy ratios,[5] both volatilities are reflected in bank share prices. This finding indicates that investors recognize the regulatory risk associated with fair value accounting.[6] In this sense, we cannot reject the possibility of increased volatility having some impact on capital allocation decisions and bank behavior. If this is the case, does it mean that regulatory capital requirements using fair value accounting are irrelevant? We deal with this issue in the next section.

Table 4
Banks' Basle Capital Adequacy Ratio Levels
1992-96

BIS-R (Percent)	1992	1993	1994	1995	1996
9.00 ~	59	70	50	59	61
8.75~9.00	15	8	12	8	6
8.50~8.75	12	8	13	7	3
8.25~8.50	1	1	9	9	8
8.00~8.25	0	0	1	1	2
7.75~8.00	0	0	0	0	0
7.50~7.75	0	0	0	0	0
7.25~7.50	0	0	0	0	0
7.00~7.25	0	0	0	0	0
~ 7.00	0	0	1	0	1

Note: BIS-R is the Basle Accord regulatory capital ratio.

5. Appropriate Accounting Formula for Capital Adequacy Ratios

In section 3, we showed that the volatility in fair value earnings is not generally recognized by investors as a better risk proxy than that in historical cost earnings. However, in section 4 we demonstrated that under critical circumstances, such as the valuation of low-capital-ratio banks' shares, the volatility in fair value earnings incremental to that in historical cost earnings is also priced as risk.

We interpret these findings as follows:

- No strong empirical evidence supports the assertion that investors generally demand an excessive premium because of the increased volatility associated with fair value accounting, therefore raising banks' cost of capital.
- However, this does not mean that fair value earnings are value-irrelevant. In fact, on those critical occasions when investors value low-capital-ratio banks' shares, fair value earnings provide us with more useful information than do historical cost earnings.

Table 5
REGRESSION ESTIMATES, SAMPLE OF LOW-CAPITAL-RATIO BANKS

$$P_{it} = \alpha_{0i} + \alpha_{0t} + \alpha_1 PREE_{it} + \alpha_2(\sigma_{HCit} \times PREE_{it}) + \alpha_3(\sigma_{FVit} - \sigma_{HCit}) \times PREE_{it} + \varepsilon_{it}$$

Coefficient estimates: $\alpha_1 = 8.43(t = 5.33)$

$\alpha_2 = -0.02(t = -3.01)$ F-test: F (31,39) = 30.472, P-value = [.0000]

$\alpha_3 = -0.008(t = -3.37)$ Hausman-test: CHISQ(3) = 23.260, P-value = [.0000]

Notes: *P* is price per share; *PREE* is earnings per share before securities gains and losses; σ_{HC} is the standard deviation of historical cost earnings per share for each bank measured over the most recent four years; σ_{FV} is the standard deviation of fair value earnings per share, calculated as historical cost earnings plus unrealized gains and losses for investment securities for each bank measured over the most recent four years; *i* is bank *i*; *t* is year *t*; *t*-statistics are in parentheses.

- We can interpret as regulatory risk associated with fair value accounting the perceived volatility in fair value earnings incremental to that in historical cost earnings in the valuation of low-capital-ratio banks' shares.

Examined from a different angle, our findings indicate that the choice of accounting formula adopted in regulatory capital requirements is very important. If an inappropriate accounting formula is adopted, there is a possibility that the regulatory capital requirements mislead investors and lead to inefficient capital allocation decisions and inappropriate bank behavior.

We now ask, how relevant is the current accounting formula used to calculate capital requirements under the terms of the 1988 Basle Accord? This question should be addressed in terms of the purpose of the bank capital standards. Broadly speaking, bank capital standards are aimed at limiting bank failures by decreasing the likelihood of bank insolvency (that is, decreasing the likelihood that banks have negative economic net worth, in which liabilities exceed assets). Therefore, banks' capital ratios should be a good indication of the future probability of banks' negative net worth. When we assess the future probability of banks' negative net worth, both assets and liabilities should be fair-valued, reflecting future risk factors.

Capital ratios based on historical cost cannot accurately indicate economic net worth. In some cases, failed institutions report positive net worth in excess of regulatory requirements under historical cost accounting, even though these institutions already have negative economic net worth. We can therefore consider relevant regulatory capital requirements using fair value accounting since these formulas lead regulators to address institutions' financial difficulties earlier.

So, what is "fair value" in the context of capital adequacy ratios? Theoretically, we consider valid the assertion that all assets and liabilities should be calculated using fair value (taking into account fluctuations in value from various risk factors, such as market risk, credit risk, and liquidity risk). However, we find it difficult, realistically, to use fair value accounting on all assets and liabilities to calculate capital adequacy ratios. We have much to explore on this matter.

In this paper, we do not deal with general risk factors or fair value accounting associated with Basle capital adequacy ratios. Our study provides evidence to support the assertion that inappropriate or incorrect fair values adopted in regulatory capital requirements should be revised, because of the possibility that they will cause inefficient capital allocations by investors and inappropriate bank behavior. From this point of view, the current Basle capital adequacy formula allows biased treatment, at least theoretically, of the calculation of unrealized gains from investment securities.[7] The current formula includes unrealized gains of investment securities only in the calculation of capital (the numerator), but assets (the denominator) should also be calculated to include unrealized gains from investment securities.

This is not only justified by theoretical arguments. Practically, this assertion is appropriate, because this alternative formula (that is, calculating unrealized gains of investment securities for denominators, as well as numerators) mitigates capital adequacy ratios' volatility. Table 3 shows a comparison of the volatility of capital adequacy ratios using the current Basle Accord formula (only capital is calculated using the unrealized gains from investment securities), the formula using historical cost accounting, and fair value formulas (both capital and assets are calculated using the unrealized gains of investment securities). Under the fair value formula, 45 percent of the unrealized gains of investment securities is included in capital (the numerator), which follows the treatment under the current formula, taking into account the concept of tax effect accounting.[8] However, assets include 100 percent of unrealized gains of investment securities. This treatment is relevant because, under tax effect accounting, profits can be adjusted but the asset side remains unchanged. Obviously, the current and fair value formulas are more volatile than the historical cost formula, but between the two former formulas, the fair value formula—calculating unrealized gains from investment securities—mitigates the increased volatility.

In Japan, the current Basle capital adequacy formula is sometimes criticized because it includes unrealized gains of investment securities in capital (the numerator), intensifying the capital adequacy ratios' volatility and therefore having an inappropriate impact on bank behavior. The findings in Table 3 show that, even from the critics' point of view, the fair value formula (calculating both capital and assets using the unrealized gains from investment securities) is more appropriate than the current formula.

6. Conclusion

This paper investigated the assertions of those who criticize the use of fair value accounting to estimate the value of investment securities. We studied the regulatory risk associated with capital adequacy ratios based on fair value accounting. We addressed these issues using earnings that we calculated using disclosed fair value estimates of banks' investment securities and Basle capital adequacy ratios, which partly adopt the concept of fair value accounting.

We reached the following conclusions:

- Although earnings are more volatile under fair value accounting, this increased volatility does not necessarily represent a proxy of economic risk.
- However, in critical circumstances—where investors value low-capital-ratio banks' shares—the volatility in fair value earnings, incremental to that in historical cost earnings, is also priced as risk.

Our first conclusion is consistent with the findings of Barth, Landsman, and Wahlen (1995), who use data on U.S. banks. However, our second conclusion is different from their empirical results. Presumably, this difference is brought about partly by differences in regulation and in bank behavior.

In the United States, banks basically are not allowed to hold equity securities and the size of these holdings is limited.[9] In Japan, however, the size of equity securities holdings is much larger,[10] thus causing volatile unrealized gains that can be considered to have more impact than in the United States on investors' valuation of banks' shares under critical circumstances.

Our conclusions suggest the following:

- The assertion that investors generally demand an excessive premium because of the increased volatility associated with fair value accounting, thereby raising banks' cost of capital, is not supported by any strong empirical evidence.
- However, this does not mean that fair value earnings are value-irrelevant. In fact, on those critical occasions when investors value low-capital-ratio banks' shares, fair value earnings provide us with more useful information than do historical cost earnings.
- The perceived volatility in fair value earnings incremental to that in historical cost earnings in the valuation of low-capital-ratio banks' shares can be interpreted as regulatory risk associated with fair value accounting and it indicates the importance of the accounting framework of the Basle capital adequacy formula. If an inappropriate accounting formula is adopted, there is a possibility that regulatory capital requirements will mislead investors and lead to inefficient capital allocation decisions and

inappropriate bank behavior. The Basle capital adequacy formula adopts in part the concept of fair value accounting in the sense that it allows the inclusion of unrealized gains of investment securities in the calculation of capital (the numerator). However, when including unrealized gains, we should also include those gains in the calculation of assets (the denominator). This assertion is supported by the fact that the fair value formula (both capital and assets are calculated using the unrealized gains of investment securities) is less volatile than the current formula.

APPENDIX: VALUATION AND CAPITAL ASSET PRICING MODELS

Suppose that the current price of a share is P_0, that the expected price at the end of a year is P_1, and that the expected dividend per share is DIV_1. We assume that the equity investors invest for both dividends and capital gains, and that expected return is *r*.

Our fundamental valuation formula is, therefore,

$$P_0 = \frac{DIV_1 + P_1}{1 + r}.$$

This formula will hold in each period, as well as in the present. That allowed us to express next year's forecast price in terms of the subsequent stream of dividends per share $DIV_1, DIV_2 \dots$. If dividends are expected to grow forever at a constant rate, *g*, then

$$P_0 = \frac{DIV_1}{r - g} = \frac{(1 + g)DIV_0}{r - g}.$$

We transform this into the following formula, where *b* is the retention rate and E_0 is the current earnings per share:

$$\text{(A1)} \qquad P_0 = \frac{(1 - b)E_1}{r - g} = \frac{(1 + g)(1 - b)E_0}{r - g} \equiv \theta E_0 .$$

We obtain the relationship that equity value equals an earnings multiple (θ) times current earnings per share E_0.

Now, we focus on expected return *r*. By using the capital asset pricing model, the following equation is obtained:

$$\text{(A2)} \qquad r_i = r_f + \beta_i(r_m - r_f) = r_f + \frac{\rho\sigma_{ri}}{\sigma_{rm}}(r_m - r_f),$$

where r_f is the risk free rate, r_m is the expected return on the market index, and ρ is the covariance $(r_i, r_m)/\sigma_{ri}\sigma_{rm}$.

When we combine equations A1 and A2, we find the earnings multiple is described in the form $1/(A + B\sigma_{ri})$. If we assume that the portion of the earnings multiple attributable to risk can be disaggregated linearly from the total earnings multiple, then we obtain equation 1 in the main text.

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ENDNOTES

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1. The investment securities holdings of 149 Japanese banks (including city banks, long-term credit banks, trust banks, regional banks, and regional banks II) on average account for 15.4 percent (in 1996) of their total assets.

2. Under the current accounting rules in Japan, banks' investment securities are recognized at historical cost (equity securities are recognized at the lower of cost or market) and estimates of their fair values are disclosed. In this paper, on the assumption that disclosure and recognition are informationally equivalent, we make fair value estimates by adding URSGL to RSGL.

3. Banks' annual statements cannot be obtained at the end of the fiscal year. However, investors may infer those figures by evaluating forecast figures in the semiannual statements, movements of interest rates, the stock price index (Nikkei Heikin), and other information sources such as from rating firms. Therefore, a bank's end-of-fiscal-year share price can be considered relevant. Incidentally, Barth, Landsman, and Wahlen (1995) analyze U.S. banks by using end-of-year data—the same type of information we use to study Japanese banks.

4. The four-year calculation period reflects the tradeoff between having a sufficient number of observations to estimate the earnings variance efficiently and having a sufficient number of observations to estimate efficiently equation 1.

5. When simply conducting the same estimation with regard to high capital adequacy ratios, the coefficient of earnings per share before securities gains and losses, as well as that of the increased volatility of fair value estimates, is insignificant. Presumably, this result is driven somewhat by the large-scale loan writeoffs in the recent years: In this situation, high earnings are not necessarily positively valued, because myopic behavior, such as reporting high profits in the short run while deferring the writeoffs of nonperforming loans, is negatively valued. Mainly large banks, such as city banks that have relatively high capital ratios, have conducted the large-scale writeoffs. At any rate, for this study we have to conduct the empirical estimation using other financial data such as the sum of writeoffs and nonperforming loans, which we think will be the subject of future studies.

6. The risk investors recognize regarding capital adequacy ratios is not limited to regulatory risk. Even without regulatory capital requirements, investors monitor the economic capital ratios of banks and, if these ratios decrease, they will demand an excessive premium. In this sense, we cannot easily draw the line between regulatory risk and risk regarding economic capital ratios. In this paper, we focus on regulatory risk and do not touch upon such issues as the meaning of capital for shareholders and managers and the meaning of internal capital allocation.

7. The treatment of unrealized gains from investment securities is left to each country's regulator. In Japan, banks are allowed to include unrealized gains from investment securities. In this paper, we consider the treatment of unrealized gains in Japan.

8. To be precise, under the current formula, the figure 45 percent is considered to be determined not only by tax effect accounting, but also by the fact that not all of unrealized profits can be realized. At any rate, regarding the inclusion of unrealized gains in the calculation of capital, we adopt the figure 45 percent in the calculation of the fair value formula to clarify the comparison with the current formula.

9. "Except as hereinafter provided or otherwise permitted by law, nothing herein contained shall authorize the purchase by the association for its own account of any shares of stock of any corporation." (Title 12, United States Code Section 24, Seventh.)

10. The investment securities holdings of U.S. commercial banks (9,528) on average account for 17.5 percent of total assets (in 1996), which is larger than the amount for Japanese banks (15.4 percent). However, the size of banks' equity securities accounts for only 2.7 percent of total holding securities, while that of Japanese banks accounts for 34.7 percent of total holding securities.

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Measuring the Relative Marginal Cost of Debt and Capital for Banks

Summary of Presentation

Thuan Le and Kevin P. Sheehan

The implicit assumption for the existence of an optimal capital structure is that the cost of capital depends on the degree of leverage and that there exists sufficient friction that prevents investors from taking advantage of arbitrage opportunities. By exploiting the equilibrium condition under an optimal capital structure—that a bank's cost of funds either from equity or debt should be equal—we derive a measure of capital bindingness. This measure suggests that, since 1993, the cost of equity capital has been very expensive relative to the cost of debt by historical standards, yet banks have not lowered their capital ratios as theory would predict.

This finding seems to indicate that banks are somehow "constrained" to holding a higher fraction of their liabilities in the form of more expensive equity capital instead of the relatively cheaper debt. Perhaps the reason that banks are constrained from lowering their capital ratios has less to do with regulatory capital requirements than the banks' inability to effectively reduce excess capital. Recent data show that banks are growing more slowly today than in the past, which would preclude increasing debt as a means of lowering the capital ratios. Empirical data suggest that banks may be attempting to reduce equity through consolidation and stock repurchases. Some may view stock repurchases as costly compared with mergers and acquisitions, but our work suggests that both methods will lower capital ratios and bring the marginal cost of debt and equity closer together.

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Commentary

Stephen G. Cecchetti

This session contains four interesting papers that are brought together by the following important question: What does it mean for a bank to be capital constrained? Put slightly differently, the papers by Ediz, Michael, and Perraudin; Aggarwal and Jacques; Yonetani and Katsuo; and Le and Sheehan all attempt to measure how banks react to the presence of capital requirements. In the following, I will summarize and comment on what I believe to be the primary focus of each of these four papers as it relates to this question. I will then close with some general remarks.

The first paper, by Ediz, Michael, and Perraudin, entitled "The Impact of Capital Requirements on U.K. Bank Behaviour," examines the behavior of British banks near the regulatory trigger levels for capital, as set by the examining authorities in the United Kingdom. The authors ask the very interesting question: What actions do banks take when their capital ratios fall close to the regulatory limit? Their conclusion is that banks approaching the limits imposed by regulators raise capital, and do not shed loans. This conclusion is valuable, as it suggests that the reaction of lenders to capital requirements is not to clamp down on their borrowers. Regulatory constraints do not, by themselves, appear to reduce the *supply* of loans.

I view Ediz, Michael, and Perraudin's results as preliminary. The authors provide a number of very interesting descriptive statistics that provide support for these conclusions. For example, they convincingly establish (graphically) that the closer a bank's capital (relative to risk-weighted assets) gets to the regulatory trigger, the more likely a bank is to increase its capital. But their sophisticated econometric analysis has one fairly large difficulty. The authors estimate a simple model in which banks have an optimal or target level of capital in mind and adjust slowly to this target. Looking at the numerical results in the paper, one finds that banks are adjusting their capital levels each year by more than the difference between the current level and the target. That is, the estimated adjustment rate exceeds one, meaning that the banks are overshooting the target (and by more and more each year).

The second paper, by Aggarwal and Jacques, is entitled "Assessing the Impact of Prompt Corrective Action on Bank Capital and Risk." The authors attempt to measure the impact of prompt corrective action (PCA) on bank capital levels and bank risk; again, an issue clearly worthy of study. In this work, Aggarwal and Jacques use

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data on bank balances for the years 1991-93. This allows the assessment of banks' behavior before and after the institution of PCA in 1992. The authors find that banks with low levels of capital at the beginning of the period increased their levels of capital by the end and reduced the riskiness of their asset portfolios (using the authors' chosen measure).

While Aggarwal and Jacques' conclusions are plausible, can we really ascribe them to prompt corrective action? In order to fully confirm the causal link from PCA to the bank balance sheet changes they document, the authors need to confront two important difficulties. First, are there plausible alternative explanations for the findings? What else happened in the 1991-93 period? And second, does their measure of risk really track the quantity of interest? Again, is there another, equally plausible interpretation of the results? With respect to the first question, a number of things happened during this period that may have contaminated the results, making this an unfortunate period to use for an attempt to isolate the impact of PCA. First, 1992 was the year in which the 1988 Basle Capital Accord was implemented in the United States. In preparation for this, banks began reporting risk-based capital in 1990-91. It seems likely that banks' behavior during this period was a reaction both to PCA and to the implementation of the Basle Capital Accord, and that sorting out their relative impact will be very difficult.

Second, the early 1990s was an unusual point in what was an important cycle in the banking industry. Prior to this, in the late 1980s through 1991, banks had taken loan losses associated with their real estate portfolios. Banks' loan-loss reserves were depleted and their capital was significantly reduced. The natural reaction of the banks in 1992-93 was to rebuild their capital positions. Was the overall reaction of bank capital during the 1991-93 period the result of prompt corrective action? Maybe, but we do not yet have convincing proof.

Aggarwal and Jacques' second set of results concerns the impact of PCA on banks' willingness to assume risk. They measure bank risk exposure as the ratio of risk-weighted assets to total assets, and presume that the higher this ratio, the more risk a bank assumes per dollar of book value. Unfortunately, this measures only credit risk, and not very well. What about other sources of risk, such as interest rate risk? I am led to conclude that they have not convincingly shown that PCA reduced the *overall* riskiness of banks' assets.

In "Fair Value Accounting and Regulatory Capital Requirements," Yonetani and Katsuo examine how market and regulatory discipline interact to affect Japanese banks. The market might perceive that banks are undercapitalized and might value their shares accordingly. But, Yonetani and Katsuo hypothesize, there may be a separate influence on the bank that comes when it actually hits its regulatory limit. At this point, does the market punish the bank even more? Or, does the market properly perceive the riskiness of the bank's asset position and value it correctly? The authors conclude that bank earnings based on fair market value are more volatile than those based on historical cost and that the impact of this additional volatility depends on the level of bank capital, suggesting that the two (negative) effects reinforce one another.

Yonetani and Katsuo's work is relevant in helping us answer a much broader question than the one on which they primarily focus: For the purposes of meeting regulatory capital requirements, at what frequency should we require banks to mark their portfolios to market? This is an extremely difficult question to answer. It seems that some market value accounting is necessary, and so "never" is not the right answer. But then, a very high frequency, even if it were cheap to administer, does not seem to be the right answer either. Should we insist that the bank's capital, at market prices, exceeds the regulatory minimum at every instant? Probably not, as some portions of a bank's portfolio may experience significantly more high-frequency volatility than low-frequency volatility. But we surely could use an answer to this question, and more work in this area would be very valuable.

The final paper in this group is Le and Sheehan's "Measuring the Relative Marginal Cost of Debt and Capital for Banks." In their study, these two authors ask whether we can measure the impact of capital requirements by looking at prices. The general idea of looking for the impact of quantity constraints by examining prices seems like a good one. Here, Le and Sheehan proceed by studying the behavior of the difference between the cost of capital and the cost of debt. Does this give us the information we really want?

In assessing their methods, one must ask whether fluctuations in the cost of capital relative to debt are likely to tell us anything about the degree to which capital requirements bind. In trying to answer this question, first ask whether the cost of capital will equal the cost of debt even if there were no capital requirements. I think that the answer to this must be no. First, capital is more risky than debt, and so it should have a higher expected rate of return. Second, even if deposit insurance cuts the link between the marginal cost of debt and the level of capital, with costly bankruptcy, the marginal cost of capital will depend on the level of debt. As a result, anything that changes the riskiness of capital or the likelihood of bankruptcy will change the cost of capital relative to debt—even if there is no capital requirement at all.

Looking briefly at Le and Sheehan's empirical results, I have two comments. First, it is very difficult to measure the *marginal* cost of capital, which is what they need. Most techniques will allow measurement of the *average* cost. Second, looking at the specifics of their results, you see that the time path of their measure of how binding the constraints are depends critically on exactly how they choose to measure it. Is the deviation of the estimated cost of capital from the estimated cost of debt calculated relative to the interest rate on Treasury bills or not? It turns out to make a big difference what measure is used, and since the authors provide no reason for one or the other, I am left puzzled.

In thinking about capital regulation generally, the problem that brings these four papers together is a fundamental one: What does it mean for banks to be capital constrained? The common methodology in addressing this question is to look at the behavior of banks as they approach the constraint imposed by regulators. But is this likely to give us an answer to the question we really care about? The one result that comes through in all of these papers is that banks that are *undercapitalized* raise capital. But surely *undercapitalized* banks will be under market pressure at the same time they come under regulatory pressure. Can we really say that the behavior we observe with the regulations is different from the behavior we would observe without them?

I realize that in these comments I have raised more questions than I have answered. My conclusion is that the success of these papers, really, is in helping us to refine the questions to which we need answers. After reading these four interesting papers, I am left asking myself two questions to which we would like to know the answers: How is it that required capital ratios work to affect bank behavior? What are capital requirements really supposed to achieve?

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SESSION 2

CREDIT RISK MODELING

Papers by

David Jones and John Mingo

Brian Gray

Thomas C. Wilson

Kenji Nishiguchi, Hiroshi Kawai, and Takanori Sazaki

Commentary by

William Perraudin

Industry Practices in Credit Risk Modeling and Internal Capital Allocations: Implications for a Models-Based Regulatory Capital Standard

Summary of Presentation

David Jones and John Mingo

I. Why Should Regulators Be Interested in Credit Risk Models?

Bank supervisors have long recognized two types of shortcomings in the Basle Accord's risk-based capital (RBC) framework. First, the regulatory measures of "capital" may not represent a bank's true capacity to absorb unexpected losses. Deficiencies in reported loan loss reserves, for example, could mask deteriorations in banks' economic net worth. Second, the denominator of the RBC ratios, total risk-weighted assets, may not be an accurate measure of total risk. The regulatory risk weights do not reflect certain risks, such as interest rate and operating risks. More importantly, they ignore critical differences in credit risk among financial instruments (for example, all commercial credits incur a 100 percent risk weight), as well as differences across banks in hedging, portfolio diversification, and the quality of risk management systems.

These anomalies have created opportunities for "regulatory capital arbitrage" that are rendering the formal RBC ratios increasingly less meaningful for the largest, most sophisticated banks. Through securitization and other financial innovations, many large banks have lowered their RBC requirements substantially without reducing materially their overall credit risk exposures. More recently, the September 1997 Market Risk Amendment to the Basle Accord has created additional arbitrage opportunities by affording certain credit risk positions much lower RBC requirements when held in the trading account rather than in the banking book.

Given the prevalence of regulatory capital arbitrage and the unstinting pace of financial innovation, the *current* Basle Accord may soon become overwhelmed. At least for the largest, most sophisticated banks, it seems clear that regulators need to begin developing the next generation of capital standards now—before the current framework is completely outmoded. "Internal models" approaches to prudential regulation are presently the only long-term solution on the horizon.

The basic problem is that securitization and other forms of capital arbitrage allow banks to achieve *effective* capital requirements well below the *nominal* 8 percent Basle standard. This may not be a concern—indeed, it may be desirable from a resource allocation perspective—when,

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in specific instances, the Basle standard is way too high in relation to a bank's true risks. But it *is* a concern when capital arbitrage lowers *overall* prudential standards. Unfortunately, with the present tools available to supervisors, it is often difficult to distinguish these cases, especially given the lack of transparency in many off-balance-sheet credit positions.

Ultimately, capital arbitrage stems from the disparities between true economic risks and the "one-size-fits-all" notion of risk embodied in the Accord. By contrast, over the past decade many of the largest banks have developed sophisticated methods for quantifying credit risks and internally allocating capital against those risks. At these institutions, credit risk models and internal capital allocations are used in a variety of management applications, such as risk-based pricing, the measurement of *risk-adjusted* profitability, and the setting of portfolio concentration limits.

II. The Relationship between PDF and Allocated Economic Capital

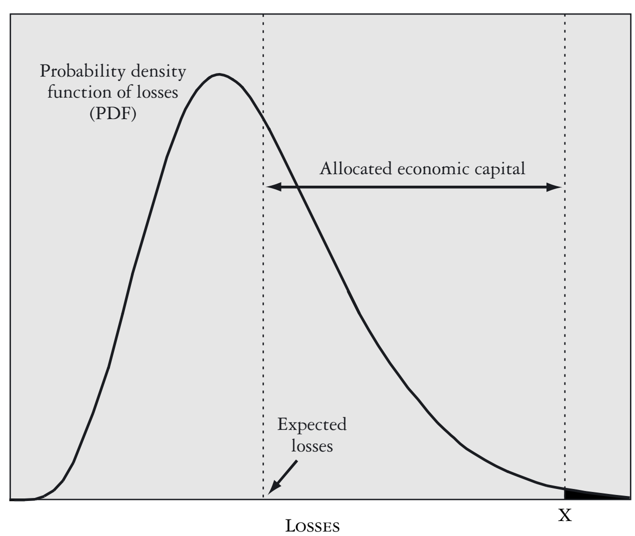
Before discussing various credit risk models per se, it may be helpful to describe how these models are used within banks' capital allocation systems. Internal capital allocations against credit risk are based on a bank's estimate of the probability density function (PDF) for credit losses. Credit risk models are used to estimate these PDFs (see chart). A risky portfolio is one whose PDF has a relatively long, fat tail—that is, where there is a significant likelihood that actual losses will be substantially higher than expected losses, shown as the left dotted line in the chart. In this chart, the probability of credit losses exceeding the level X is equal to the shaded area under the PDF to the right of X.

The estimated capital needed to support a bank's credit risk exposure is generally referred to as its "economic capital" for credit risk. The process for determining this amount is analogous to VaR methods used in allocating economic capital against market risks. Specifically, the economic capital for credit risk is determined in such a way that the estimated probability of *unexpected* credit losses exhausting economic capital is less than the bank's "target insolvency rate." Capital allocation systems generally assume that it is the role of reserving policies to cover *expected* credit losses, while it is the role of equity capital to cover *credit risk,* or the *uncertainty* of credit losses. Thus, required economic capital is the amount of equity over and above expected losses necessary to achieve the target insolvency rate. In the chart, for a target insolvency rate equal to the shaded area, the required economic capital equals the distance between the two dotted lines.

In practice, the target insolvency rate is usually chosen to be consistent with the bank's desired credit rating. For example, if the desired credit rating is AA, the target insolvency rate might equal the historical one-year default rate for AA-rated corporate bonds (about 3 basis points).

To recap, economic capital allocations for credit risk are based on two critical inputs: the bank's target insolvency rate and its estimated PDF for credit losses. Two banks with identical portfolios, therefore, could have very different economic capital allocations for credit risk, owing to differences in their attitudes toward risk taking, as reflected in their target insolvency rates, or owing to differences in their methods for estimating PDFs, as reflected in

The Relationship between PDF and Allocated Economic Capital Losses



Note: The shaded area under the PDF to the right of X (the target insolvency rate) equals the cumulative probability that unexpected losses will exceed the allocated economic capital.

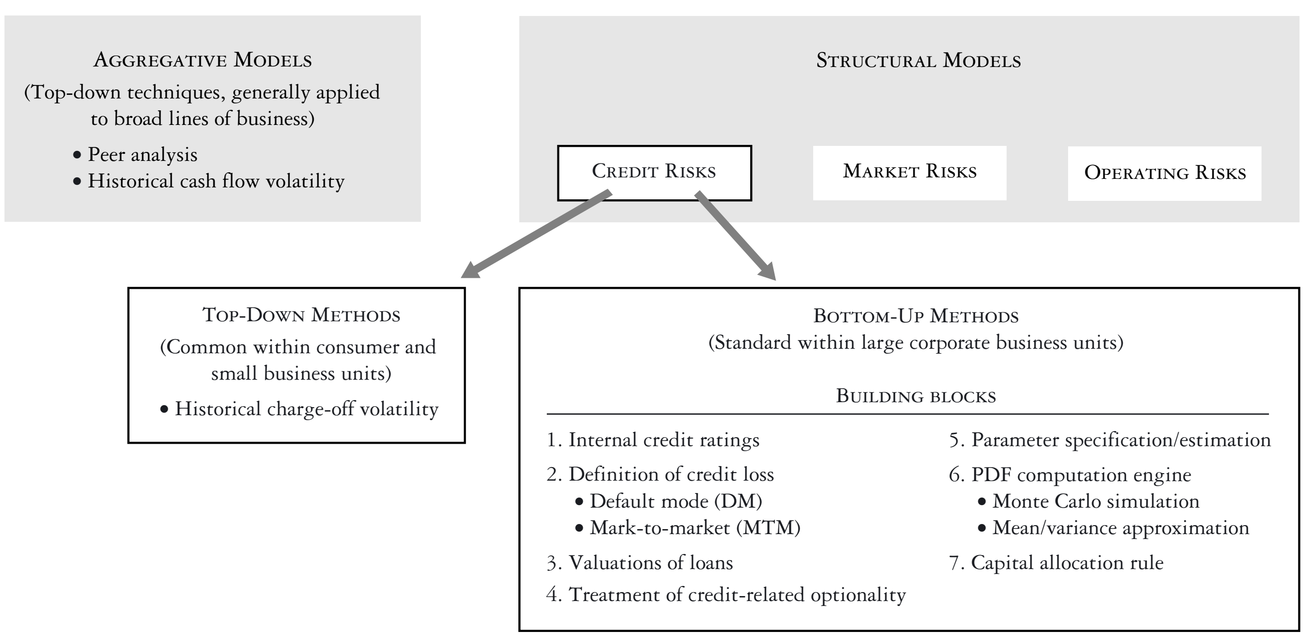
their credit risk models. Obviously, for competitive equity and other reasons, regulators prefer to apply the same minimum soundness standard to all banks. Thus, any internal models approach to regulatory capital would likely be based on a bank's estimated PDF, not on the bank's *own* internal economic capital allocations. That is, the regulator would likely (a) decide whether the bank's PDF estimation process was acceptable and (b) at least implicitly, set a regulatory maximum insolvency probability (rather than accept the bank's target insolvency rate if such a rate was deemed "too high" by regulatory standards).

III. Types of Credit Risk Models

When estimating the PDF for credit losses, banks generally employ what we term either "top-down" or "bottom-up" methods (see exhibit). Top-down models are often used for estimating credit risk in consumer or small business portfolios. Typically, within a broad subportfolio, such as credit cards, all loans would be treated as more or less homogeneous. The bank would then base its estimated PDF on the *historical* credit loss rates for that subportfolio taken as a whole. For example, the variance in subportfolio loss rates over time could be taken as an estimate of the variance of loss rates associated with the current subportfolio. A limitation of top-down models, however, is that they may not be sensitive to changes in the subportfolio's composition. That is, if the quality of the bank's card customers were to change over time, PDF estimates based on that portfolio's historical loss rates could be highly misleading.

Where changes in portfolio composition are a significant concern, banks appear to be evolving toward bottom-up models. This is already the predominant method for measuring the credit risks of large and middle-market customers. A bottom-up model attempts to quantify credit risk at the level of each individual loan, based on an explicit credit evaluation of the underlying customer. This evaluation is usually summarized in terms of the loan's internal credit rating, which is treated as a proxy for the loan's probability of default. The bank would also estimate the loan's loss rate in the event of default, based on collateral and other factors. To measure credit risk for the portfolio as a whole, the risks of individual loans are aggregated, taking into account correlation effects. Unlike top-down methods, therefore, bottom-up models explicitly consider variations in credit quality and other compositional effects.

Overview of Risk Measurement Systems



IV. Modeling Issues

The remainder of this summary focuses on four aspects of credit risk modeling: the conceptual framework, credit-related optionality, model calibrations, and model validation. The intent is to highlight some of the modeling issues that we believe are significant from a regulator's perspective; the full version of our paper provides significantly greater detail.

A. Conceptual Framework

Credit risk modeling procedures are driven importantly by a bank's underlying definition of "credit losses" and the "planning horizon" over which such losses are measured. Banks generally employ a one-year planning horizon and what we refer to as either a default-mode (DM) paradigm or a mark-to-market (MTM) paradigm for defining credit losses.

1. Default-Mode Paradigm

At present, the default-mode paradigm is by far the most common approach to defining credit losses. It can be thought of as a representation of the traditional "buy-and-hold" lending business of commercial banks. It is sometimes called a "two-state" model because only two outcomes are relevant: nondefault and default. If a loan does *not* default within the planning horizon, no credit loss is incurred; if the loan defaults, the credit loss equals the difference between the loan's book value and the present value of its net recoveries.

2. Mark-to-Market Paradigm

The mark-to-market paradigm generalizes this approach by recognizing that the economic value of a loan may decline even if the loan does not formally default. This paradigm is "multi-state" in that "default" is only one of several possible credit ratings to which a loan could migrate. In effect, the credit portfolio is assumed to be marked to market or, more accurately, "marked to model." The value of a term loan, for example, typically would employ a discounted cash flow methodology, where the credit spreads used in valuing the loan would depend on the instrument's credit rating.

To illustrate the differences between these two paradigms, consider a loan having an internal credit rating equivalent to BBB. Under both paradigms, the loan would incur a credit loss if it were to default during the planning horizon. Under the mark-to-market paradigm, however, credit losses could *also* arise if the loan were to suffer a downgrade short of default (such as migrating from BBB to BB) or if prevailing credit spreads were to widen. Conversely, the value of the loan could increase if its credit rating improved or if credit spreads narrowed.

Clearly, the planning horizon and loss paradigm are critical decision variables in the credit risk modeling process. As noted, the planning horizon is generally taken to be one year. It is often suggested that one year represents a reasonable interval over which a bank—in the normal course of business—could mitigate its credit exposures. Regulators, however, tend to frame the issue differently—in the context of a bank under *stress* attempting to unload the credit risk of a significant portfolio of deteriorating assets. Based on experience in the United States and elsewhere, *more* than one year is often needed to resolve asset-quality problems at troubled banks. Thus, for the banking book, regulators may be uncomfortable with the assumption that capital is needed to cover only one year of unexpected losses.

Since default-mode models *ignore* credit deteriorations short of default, their estimates of credit risk may be particularly sensitive to the choice of a one-year horizon. With respect to a three-year term loan, for example, the one-year horizon could mean that more than two-thirds of the credit risk is potentially ignored. Many banks attempt to reduce this bias by making a loan's estimated probability of default an increasing function of its maturity. In practice, however, these adjustments are often made in an ad hoc fashion, so it is difficult to assess their effectiveness.

B. Credit-Related Optionality

In contrast to simple loans, for many instruments a bank's credit exposure is not fixed in advance, but rather depends on future (random) events. One example of such "credit-related optionality" is a line of credit, where optionality reflects the fact that drawdown rates tend to increase as a customer's credit quality deteriorates. As observed in connection with the recent turmoil in foreign exchange markets, credit-related optionality also arises in derivatives transactions, where counterparty exposure changes randomly over the life of the contract, reflecting changes in the amount by which the bank is "in the money."

As with the treatment of optionality in VaR models, credit-related optionality is a complex topic, and methods for dealing with it are still evolving. At present, there is great diversity in practice, which frequently leads to very large differences across banks in credit risk estimates for similar instruments. With regard to virtually identical lines of credit, estimates of stand-alone credit risk can differ as much as a tenfold. In some cases, these differences reflect modeling assumptions that, quite frankly, seem difficult to justify—for example, with respect to committed lines of credit, some banks implicitly assume that future draw-down rates are *independent* of future changes in a customer's credit quality. Going forward, in our view the treatment of credit-related optionality needs to be a priority item, both for bank risk modelers and their supervisors.

C. Model Calibration

Perhaps the most difficult aspect of credit risk modeling is the calibration of model parameters. To illustrate this process, note that in a default-mode model, the credit loss for an individual loan reflects the combined influence of two types of risk factors—those determining whether or not the loan defaults and, in the event of default, risk factors determining the loan's loss rate. Thus, implicitly or explicitly, the model builder must specify (a) the expected probability of default for each loan, (b) the probability distribution for each loan's loss-rate-given-default, and (c) among all loans in the portfolio, *all* possible pair-wise correlations among defaults and loss-rates-given-default. Under the mark-to-market paradigm, the estimation problem is even more complex, since the model builder needs to consider possible credit rating migrations short of default as well as potential changes in future credit spreads.

This is a daunting task. Reflecting the longer term nature of credit cycles, even in the best of circumstances—assuming parameter stability—many years of data, spanning multiple credit cycles, would be needed to estimate default probabilities, correlations, and other key parameters with good precision. At most banks, however, data on historical loan performance have been warehoused only since the implementation of their capital allocation systems, often within the last few years. Owing to such data limitations, the model specification process tends to involve many crucial simplifying assumptions as well as considerable judgment.

In our full paper, we discuss assumptions that are often invoked to make model calibration manageable. Examples include assumptions of parameter stability and various forms of independence within and among the various types of risk factors. Some specifications also impose normality or other parametric assumptions on the underlying probability distributions.

It is important to note that estimation of the extreme tail of the PDF is likely to be highly sensitive to these assumptions and to estimates of key parameters. Surprisingly, in practice there is generally little analysis supporting critical modeling assumptions. Nor is it standard practice to conduct sensitivity testing of a model's vulnerability to key parameters. Indeed, practitioners generally presume that all parameters are known with certainty, thus ignoring credit risk issues arising from parameter uncertainty or model instability. In the context of an internal models approach to regulatory capital for credit risk, sensitivity testing and the treatment of parameter uncertainty would likely be areas of keen supervisory interest.

D. Model Validation

Given the difficulties associated with calibrating credit risk models, one's attention quickly focuses on the need for effective model *validation* procedures. However, the same data problems that make it difficult to calibrate these models also make it difficult to validate the models. Owing to insufficient data for out-of-sample testing, banks generally do not conduct statistical back testing on their estimated PDFs.

Instead, credit risk models tend to be validated indirectly, through various market-based "reality" checks.

Peer-group analysis is used extensively to gauge the reasonableness of a bank's overall capital allocation process. Another market-based technique involves comparing actual credit spreads on corporate bonds or syndicated loans with the break-even spreads implied by the bank's internal pricing models. Clearly, an implicit assumption of these techniques is that prevailing market perceptions and prevailing credit spreads are always "about right."

In principle, *stress testing* could at least partially compensate for shortcomings in available back-testing methods. In the context of VaR models, for example, stress tests designed to simulate hypothetical shocks provide useful checks on the reasonableness of the required capital levels generated by these models. Presumably, stress-testing protocols also could be developed for credit risk models, although we are not yet aware of banks actively pursuing this approach.

V. Possible Near-Term Applications of Credit Risk Models

While the reliability concerns raised above in connection with the *current* generation of credit risk models are substantial, they do not appear to be insurmountable. Credit risk models are progressing so rapidly it is conceivable they could become the foundation for a new approach to setting formal regulatory capital requirements within a reasonably near time frame. Regardless of how formal RBC standards evolve over time, within the short run supervisors need to improve their existing methods for assessing bank capital adequacy, which are rapidly becoming outmoded in the face of technological and financial innovation. Consistent with the notion of "risk-focused" supervision, such new efforts should take full advantage of banks' own internal risk management systems—which generally reflect the most accurate information about their credit exposures—and should focus on encouraging improvements to these systems over time.

Within the relatively near term, we believe that there are at least two broad areas in which the inputs or outputs of bank's internal credit risk models might usefully be incorporated into prudential capital policies. These include (a) the *selective* use of internal credit risk models in setting formal RBC requirements against certain credit positions that are not treated effectively within the current Basle Accord and (b) the use of internal credit ratings and other components of credit risk models for purposes of developing specific and practicable *examination* guidance for assessing the capital adequacy of large, complex banking organizations.

A. Selective Use in Formal RBC Requirements

Under the current RBC standards, certain credit risk positions are treated ineffectually or, in some cases, ignored altogether. The selective application of internal risk models in this area could fill an important void in the current RBC framework for those instruments that, by virtue of their being at the forefront of financial innovation, are the most difficult to address effectively through existing prudential techniques.

One particular application is suggested by the November 1997 Notice of Proposed Rulemaking on Recourse and Direct Credit Substitutes (NPR) put forth by the U.S. banking agencies. The NPR discusses numerous anomalies regarding the current RBC treatment of recourse and other credit enhancements supporting banks' securitization activities. In this area, the Basle Accord often produces dramatically divergent RBC requirements for essentially equivalent credit risks, depending on the specific contractual form through which the bank assumes those risks.

To address some of these inconsistencies, the NPR proposes setting RBC requirements for securitization-related credit enhancements on the basis of credit ratings for these positions obtained from one or more accredited rating agencies. One concern with this proposal is that it may be costly for banks to obtain formal credit ratings for credit enhancements that currently are not publicly rated. In addition, many large banks already produce internal credit ratings for such instruments, which, given the quality of their internal control systems, may be at least as accurate as the ratings that would be produced by accredited rating agencies. A natural extension of the agencies' proposal would permit a bank to use its *internal* credit ratings (in lieu of having to obtain *external* ratings from accredited rating agencies), provided they were judged to be "reliable" by supervisors.

A further extension of the agency proposal might involve the direct use of internal credit risk models in setting formal RBC requirements for *selected* classes of securitization-related credit enhancements. Many current securitization structures were not contemplated when the Accord was drafted, and cannot be addressed effectively within the current RBC framework. Market acceptance of securitization programs, however, is based heavily on the ability of issuers to quantify (or place reasonable upper bounds on) the credit risks of the underlying pools of securitized assets. The application of internal credit risk models, if deemed "reliable" by supervisors, could provide the first practical means of assigning economically reasonable capital requirements against such instruments. The development of an internal models approach to RBC requirements—on a limited scale for selected instruments—also would provide a useful test bed for enhancing supervisors' understanding of and confidence in such models, and for considering possible expanded regulatory capital applications over time.

B. Improved Examination Guidance

As noted above, most large U.S. banks today have highly disciplined systems for grading the credit quality of individual financial instruments within major portions of their credit portfolios (such as large business customers). In combination with other information from banks' internal risk models, these internal grades could provide a basis for developing specific and practical examination guidance to aid examiners in conducting independent assessments of the capital adequacy of large, complex banking organizations.

To give one example, in contrast to the one-size-fits-all Basle standard, a bank's internal capital allocation against a fully funded, unsecured commercial loan will generally vary with the loan's internal credit rating. Typical internal capital allocations often range from 1 percent or less for a grade-1 loan, to 14 percent or more for a grade-6 loan (in a credit rating system with six "pass" grades). Internal economic capital allocations against classified, but not-yet-charged-off, loans may approach 40 percent—*not* counting any reserves for expected future charge-offs. Examiners could usefully compare a particular bank's actual capital levels (or its allocated capital levels) with the capital levels implied by such a grade-by-grade analysis (using as benchmarks the internal capital allocation ratios, by grade, of peer institutions). At a minimum, such a comparison could initiate discussions with the bank on the reliability of its internal approaches to risk measurement and capital allocation. Over time, examination guidance might evolve to encompass additional elements of banks' internal risk models, including analytical tools based on stress-test methodologies. Regardless of the specific details, the development and field testing of examination guidance on the use of internal credit risk models would provide useful insights into the longer term feasibility of an internal models approach to setting formal regulatory capital standards.

More generally, both supervisors and the banking industry would benefit from the development of sound practice guidance on the design, implementation, and application of internal risk models and capital allocation systems. Although important concerns remain, this field has progressed rapidly in recent years, reflecting the growing awareness that effective risk *measurement* is a critical ingredient to effective risk *management.* As with trading account VaR models at a similar stage of development, banking supervisors are in a unique position to disseminate information on best practices in the risk measurement arena. In additional to permitting individual banks to compare their practices with those of peers, such efforts would likely stimulate constructive discussions among supervisors and bankers on ways to improve current risk modeling practices, including model validation procedures.

VI. Concluding Remarks

The above discussion provides examples by which information from internal credit risk models might be usefully incorporated into regulatory or supervisory capital policies. In view of the modeling concerns described in this summary, incorporating internal credit risk measurement and capital allocation systems into the supervisory and/or regulatory framework will occur neither quickly nor without significant difficulties. Nevertheless, supervisors should not be dissuaded from embarking on such an endeavor. The current one-size-fits-all system of risk-based capital requirements increasingly is inadequate to the task of measuring large bank soundness. Moreover, the process of "patching" regulatory capital "leaks" as they occur appears to be less and less effective in dealing with the challenges posed by ongoing financial innovation and regulatory capital arbitrage. Finally, despite difficulties with an internal models approach to bank capital, no alternative long-term solutions have yet emerged.

Endnote

The views expressed in this summary are those of the authors and do not necessarily reflect those of the Federal Reserve System or other members of its staff. This paper draws heavily upon information obtained through our participation in an ongoing Federal Reserve System task force that has been reviewing the internal credit risk modeling and capital allocation processes of major U.S. banking organizations. The paper reflects comments from other members of that task force and Federal Reserve staff, including Thomas Boemio, Raphael Bostic, Roger Cole, Edward Ettin, Michael Gordy, Diana Hancock, Beverly Hirtle, James Houpt, Myron Kwast, Mark Levonian, Chris Malloy, James Nelson, Thomas Oravez, Patrick Parkinson, and Thomas Williams. In addition, we have benefited greatly from discussions with numerous practitioners in the risk management arena, especially John Drzik of Oliver, Wyman & Company. We alone, of course, are responsible for any remaining errors.

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Jones, David, and John Mingo. 1998. "Industry Practices in Credit Risk Modeling and Internal Capital Allocations: Implications for a Models-Based Regulatory Capital Standard." Paper presented at the conference "Financial Services at the Crossroads: Capital Regulation in the Twenty-First Century," Federal Reserve Bank of New York, February 26-27.

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Credit Risk in the Australian Banking Sector

Brian Gray

This paper presents a brief overview of developments currently taking place in the Australian banking sector relating to the measurement and management of credit risk. Section I provides, as background, a sketch of the structure of banking in Australia. Section II considers some of the forces operating within the Australian banking and financial system to increase the significance of credit and capital management in banks. Section III outlines some of the credit risk management practices being adopted in the major Australian banks. Section IV looks at the implications of these developments and speculates on the scope for greater use of banks' internal credit risk models, or other possible approaches, for capital adequacy purposes. A summary and brief conclusion are in Section V.

I. THE STRUCTURE OF BANKING IN AUSTRALIA

The banking system in Australia can be summarised in a number of simple statistics. It comprises forty-three banking groups, with aggregate global assets totaling more than A$900 billion. Asset size, including the credit equivalent of all off-balance-sheet activity, ranges from around A$250 billion for the largest bank to around A$300 million for the smallest. As a group, banks hold more than 75 percent of the assets held by all financial intermediaries in Australia. The four major banking groups account for more than 75 percent of that total. Measured in terms of the assets of the financial system as a whole (including insurance companies and fund managers), banks now account for just less than 50 percent.

The history of banking in Australia can be summarised as one in which a long period of heavy regulation was followed by a period (dating from the late 1970s to the early 1980s) of financial deregulation. Banks dominated the system in absolute terms for many years but lost ground over the years to the newly emerging (and largely unregulated) nonbank sector. Between the late 1920s and 1980, banks' share of intermediated assets fell from around 90 percent to about 55 percent. That trend changed with the advent of financial deregulation. The long-term slide in the proportion of financial assets held by the banks was halted, and the expansion in the number of domestic and foreign banks operating in the Australian market, combined with the additional freedoms given to banks as a result of deregulation, enabled banks' share of business to rise. These trends have been widely documented and will not be examined in this paper.

In contrast to the position in a number of countries, banking in Australia encompasses all aspects of

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financial intermediation. Banks are the main providers of funds to households (through personal lending and lending for residential housing) as well as to the small and medium-sized business sectors. They are involved heavily in wholesale and institutional markets, including all aspects of traded markets. Through fully owned subsidiaries, they are prominent in insurance and funds management. There are no limitations or artificial barriers of substance to the type of activity that can be conducted through a bank or its associated companies, provided the activity can be classified as financial in nature.

II. Risk Management and the Underlying Forces in Australian Banking

Three sets of forces have been instrumental in generating greater interest over the past five years in risk measurement and management within the Australian banking system:

- the after-effects of the 1988 and 1992 periods, which saw some Australian banks suffer large losses (Chart 1). This experience led to a recognition that in a world characterised by financial deregulation, the potential existed for large volatility in earnings (and potentially large losses) induced by credit cycles. The product was a new-found interest on the part of bank management in ways to measure and manage credit and other forms of risk more precisely so as to avoid, as far as possible, the reemergence of such problems in the future.

- a recognition that the increasing volume and complexity of financial instruments and products required that better ways be found to measure associated risks. Growth and increasing complexity were not limited to traded financial products, but also extended to many balance-sheet products offered to the household and business sectors that involved complex structures, often incorporating hard-to-measure degrees of optionality.

- the structural changes taking place in the financial sector and the growth in competitive pressures. Despite the post-deregulation resurgence in the growth of "banking" as opposed to "nonbank" activities, the middle years of the 1990s and beyond have been a period of increasingly strong competition in the financial system, and that trend is likely to continue. Against a background of falling underlying profitability, banks have begun to place greater focus than ever before on the maintenance of shareholder returns and the potential for improved risk measurement and management practices to enhance performance through better portfolio selection and management.

This is the broad canvas against which the issue of possible regulatory-induced inefficiencies has emerged in the Australian market. Central to the Australian regulatory system is the 1988 Capital Accord, which (among other things) provided a rough rule-of-thumb for the measurement of required regulatory capital. The capital adequacy arrangements were readily accepted within the Australian banking system and, for a long time (often to the frustration of bank supervisors), were even used as an internal mechanism for allocating capital within at least some banks. This was possible, in large part, because banks' capital levels were well in excess of the regulatory minimum; in reality, capital allocation (to the extent that it was practiced at all) was very much a mechanical process with little meaning to the actual business activities of banks (Chart 2).

That situation is now in the process of changing and the gap between the current capital adequacy arrangements and the work being carried out by banks in relation to credit risk is becoming more apparent. Analogies are being drawn between the innovative regulatory approach adopted for traded market risk and the existing credit standards. At this stage, the arguments being presented by the main Australian banks are still in the early stages of development, and it could not be said that there is a strong consensus for change, at present, to the existing arrangements.

Chart 1

Banks' Operating Profit Attributable to Shareholders
Ratio to Average Shareholders' Funds

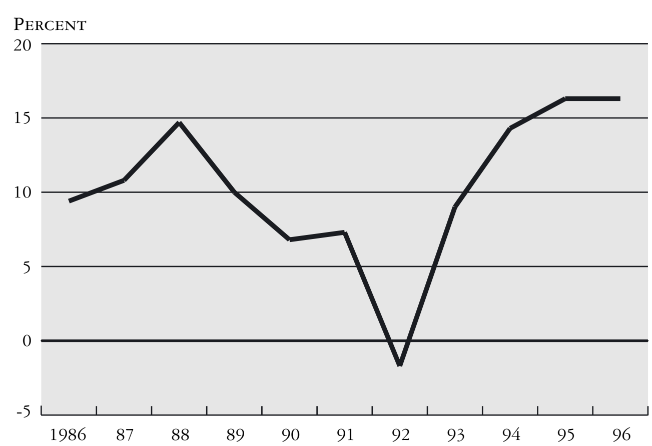
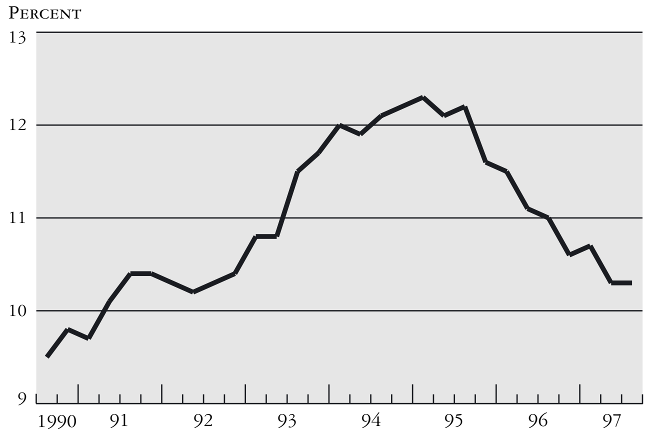


Chart 2

AGGREGATE CAPITAL RATIO
Australian Banking System



However, it is only a matter of time before calls for change become more pronounced. Now would seem to be the right time, therefore, to think seriously about how an alternative approach to the treatment of regulatory capital might be developed.

III. CREDIT RISK MANAGEMENT IN AUSTRALIAN BANKS

What is the current state of play concerning credit risk management in the Australian banking system? While it is difficult in a short paper to outline the full scope of activities taking place, and the pace of evolution, this section attempts to give an impressionistic feeling for the nature of changes we are seeing.

First, some general observations. As discussed above, there is no doubt that up until the early 1990s, credit risk measurement was at a rudimentary level in Australian banks, while the management of credit risk was largely subjective. It was a system that relied on experienced and skilled credit officers within the banks. Little attention was paid to assessing, in an objective manner, the nature and extent of credit exposures. In some cases, formal credit systems (in the modern sense of the term) were virtually nonexistent.

Since then, Australian banks have greatly improved their credit measurement capabilities as well as the broader systems in place to track and report on credit exposures. This is possibly the key finding of the program of credit risk visits initiated by the Reserve Bank of Australia in 1992. Credit processes are now better documented and understood within institutions. Asset and security valuation arrangements, a particular problem during the last credit cycle, are much tighter than in the past. There is a new focus on the accuracy and timeliness of information on counterparties. There is now widespread use within banks of risk grading systems, and credit approval and monitoring processes are being automated. There is now greater separation between the credit and marketing functions within banks. In some places, centralised credit bureaus have been developed to draw together information on, and take responsibility for, credit risk management at the group level. A more recent trend has been the emergence of centralised and independent risk management groups that seek to assess, in an integrated fashion, all risks faced by a banking group (such as credit, market, operational, and legal). The output of such groups is routinely circulated to senior management within banks and bank boards.

The criteria necessary to assess the effectiveness of risk management systems are, of course, multifaceted, touching on such issues as the quantity and quality of underlying data collected on customers and their exposures, through to the extent to which formal risk grading is used, how it is used, the degree to which pricing of exposures is linked to the grading system, whether risk-adjusted returns are measured and used within an institution, and the extent to which broader portfolio modeling is adopted to take into account correlations between counterparty and/or industry exposures. Once again, the general conclusion is that techniques are evolving rapidly, though the rigour of the methodologies used and the comprehensiveness of credit risk management processes vary among banks. There is no doubt that in relation to some of the more complex or leading-edge aspects of credit risk measurement and portfolio management, "thinking" on what is required is still well ahead of actual application or implementation.

Some of the criteria by which credit risk management systems might be judged, described above, are considered in greater detail below. For the purposes of discussion, the focus will be mainly on the larger Australian banks.

Data Collection

Banks now store a wide range of information on counterparties, from the value of all exposures measured across the whole banking group and against limits, to a wealth of financial and other information on the counterparty, including a history of share prices, where applicable. Typically, data required to conduct extensive cash flow analysis on borrowing firms as well as on associated industry prospects are now collected or calculated. While there has been significant progress in risk-based data collection by Australian banks, in many cases the data sets still cover only relatively short time frames. This reflects the fact that many banks did not collect extensive risk-related information, or did not store such information in a useful form, prior to the upsurge of work in this area over the past few years. Access to good quality, risk-related data remains an important constraint to the wider application of credit analysis and modeling within the Australian system.

Risk Grading

Risk grading is now carried out by the bulk of Australian banks. Though subjective assessment is still used by banks (as it should be), energy has been devoted to the application of statistical techniques to introduce greater objectivity into the grading process and to provide benchmarks against which subjective assessments can be gauged. Credit application and behavioural scoring are now commonplace where retail/consumer portfolios are concerned, with tailored models used for the measurement of risk in the corporate and institutional banking areas. Grading systems naturally tend to vary between banks, with the number of grades and demarcations between grades reflecting the structure of banks' balance sheets. Where possible, gradings are benchmarked, in the absence of comparable Australian data, against U.S. default and loss data compiled by Moody's and Standard and Poor's or assessed against KMV or like methodologies. Some banks have adopted external models to assist in the risk grading and portfolio management process. In others, the output of grading systems is carried through to an assessment of the required level of general provisions (a process termed "dynamic provisioning") and then through to profit and loss.

Risk Grading and Pricing

A logical extension of risk grading is the determination of risk-adjusted pricing for exposures. At this stage at least, it is not clear that this process has gone far within the Australian banking system. Some banks have certainly used their estimates of risk to decline exposures that do not meet their risk/return requirements, and there has been a definite move away from the simple "pass/fail" mentality of the past to one more sympathetic to the view that riskiness is a continuum that should be reflected in pricing. However, a common theme of risk managers in Australian banks is the difficulty in introducing more active pricing for risk regimes within their banks; the difficulty being "selling" the idea that an otherwise good exposure should not be accepted because a "technical" assessment shows that there is an imbalance between risk and expected return. It is an especially difficult message to convey to senior bank management when competitive pressures in the market are strong. This raises the broader issue of the "cultural" changes needed within a bank to make risk management (broadly defined) truly effective, and the need for an extensive "top down" education process within financial institutions. This issue is touched upon further below.

Measurement of Risk-Adjusted Performance

The leading Australian banks have begun to measure risk-adjusted performance and estimate "economic" measures of capital. The accuracy of these measures will, of course, turn on how well the underlying data and the related grading systems capture risk. The absence of comprehensive data on how well or otherwise the Australian banking sector performs in times of economic downturn will, for some time, place a question mark on the reliance that can be put on such figures, especially those relating to business and corporate loan exposures. Nonetheless, the estimates are being produced routinely by the leading banks and circulated to the highest levels within the banks. In some banks, remuneration policies are now being geared off of risk-adjusted performance measures.

Use of Broader Portfolio Models

While it is acknowledged that there are benefits to be gained in adopting active portfolio diversification techniques, the leading Australian banks are still very much at the experimental stage in examining the potential offered by such approaches. Allen (1997) has summarised the state of play in relation to portfolio diversification techniques and their applicability to Australian banks. His analysis and conclusions are not repeated here. Suffice to say that it is likely to be some time before the potential advantages offered by portfolio-based approaches are implemented within the institutions. Short of full acceptance of such techniques, however, banks have begun to experiment with buying and selling loans to realise better balanced portfolios while credit derivatives are being used more actively to the same effect (though the market in Australia is still quite small). Securitisation of banks' more homogeneous portfolios has been a feature of the Australian banking scene for several years, though there have been only limited attempts to date to securitise other, less uniform credit portfolios.

To summarise, the past five years have witnessed a rapid evolution in approaches to credit risk in the Australian banking system. Whether "world best practice" can realistically be applied to present credit risk measurement and management practices in all the leading Australian banks is questionable, though it is equally questionable just how many international banks with balance sheets comparable to Australian banks would justify that description.

A useful trend observed in this market is the recognition (referred to above) that improving risk management within banks is as much about changing attitudes to risk as it is about introducing complex technical models to the organisation. It is important to avoid the temptation to view the issue of improved risk management as essentially technical in nature. Nimmo (1997) recently referred to the challenges of improving risk management within a major bank in the following terms:

> Improved risk management, therefore, requires significant cultural change to make it effective. Implementation creates a great deal of discomfort amongst bank staff because it requires people to move away from traditional ways of doing things, to ways that are more logical but nonetheless unfamiliar. There is typically huge resistance to that process of change. Nevertheless, these changes have to be implemented in such a way that they form a fundamental part of the management of financial institutions. . . . The question is whether the commitment exists within institutions to actually make the changes which, in time, will deliver the shareholder value that waits to be extracted.

IV. Implications for Supervisors

Risk management practices have improved in the Australian banking system and the range of techniques now being applied is expanding and growing in complexity. To what extent does this suggest the need for supervisors to reassess their current approach to the measurement of regulatory capital?

It could be argued that while such developments are highly desirable in their own right, they have little implication for supervisors whose role is to set minimum supervisory and capital standards. Existing capital adequacy arrangements could be seen as satisfying this role—maintaining the pressure on minimum capital levels and generally ensuring better coordination of capital rules internationally (one of the original aims). Provided that the arrangements are not used by banks to influence lending or portfolio decisions (which should always be the product of more sophisticated methodologies than those imposed by supervisors), then the implications of retaining the existing arrangements should not be too significant.

There are a number of counterarguments, but the key one relates to the issues of supervisory relevance and financial market efficiency. While there is little reason for bank supervisors to lead the market in the application of new risk technologies for supervisory purposes (a strong case can be made against taking that approach), there are also problems in their falling behind market developments. Effective supervision hinges, in large part, on supervisors maintaining credibility and being able to demonstrate that their policies have relevance to the world in which they apply. That was the case in 1988, when the capital adequacy arrangements were first introduced, and it can also be said of the recent amendment to the Capital Accord covering market risk. If the banking industry is developing better methods for the measurement and management of risk, and genuinely using those techniques in their risk management activities, then it is reasonable to expect that supervisors will assess those developments against existing arrangements.

Competitive pressures in banking also need to be borne in mind. There has been an increasing tendency in the Australian market for nontraditional providers of finance to enter and compete strongly in areas formerly occupied mainly by banks. That trend, which is likely to become stronger over time, should be encouraged in the interests of greater competition. In many cases, however, these new providers are not supervised as intermediaries, nor should they be given the particular structures under which some of them operate (through securitisation vehicles and so on). One effect of the new competition in banking, therefore, may be to increase the competitive disadvantages associated with current forms of regulation, a point already made strongly by some banks. Market efficiency considerations, therefore, come into the equation and further strengthen the case to look at alternative regulatory options.

Internal Models

The obvious option to consider is the use of internal credit models for regulatory purposes. The issue is more complex, however, than simply observing the increased use of such models in the market and concluding that they should be applied for supervisory purposes. Even if such an approach was accepted as a good idea in principle, the real question is how the arrangement could be made workable, be efficient from a market perspective, and satisfy prudential objectives. There are some significant obstacles.

The fact that credit risk is the biggest risk factor confronting most banks is a major issue and possibly a key obstacle to the adoption of internal models. While market risk has the potential to cause serious damage to some banks, it is relatively insignificant for the bulk of Australian banks. The risk of experimenting with alternative methodologies, therefore, is much less critical where market risk, as opposed to credit risk, is concerned.

As discussed above, the practical matter of data will always be a critical problem where credit risk modeling is concerned. In Australia's case, for example, there is no long-term history of default and loss rates across different categories or grades of counterparty; that observation would hold true for many other countries as well. The data that are available (mainly from the United States) show a wide variation in risk across different gradings. For the lower grades, risks also appear highly cyclical, skewed, and "fat tailed." This means that the determination or interpretation of average and worst-case loss, or volatility of loss, is much more complex for credit risk than for traded market risk, where price and volatility data, and hence estimates of losses or gains, can be estimated continuously. Yet getting the numbers right in relation to credit risk is critical. Migration from one credit grading to another lower grading can often involve exponential increases in default risk. Capital adequacy arrangements built on inadequate or incomplete data may, therefore, generate dangerously inadequate results. The skeptic might conclude, on that basis alone, that internal models offer little, but carry very significant risks.

Yet as we look at the current arrangements, it is hard to believe that they could be the appropriate regulatory model to take the rapidly evolving banking system into the next century. The simplicity of the present framework, which at the beginning was one of its great virtues, will, in a more complex financial system, become its greatest failing. The financial world has become more complex and the regulatory world must move in step. The issue, therefore, is not whether regulatory arrangements should be modernised, but rather how they can be achieved in a balanced way, in a reasonable time frame.

As the world of internal models is approached, it will almost certainly be argued that problems of consistency will arise—how to ensure equal treatment across different institutions. It should be recognised, however, that simple approaches already suffer severely from this problem. To use an admittedly overly used example, the current system can generate the same capital requirement for a bank holding only blue-chip corporate exposures as it can for another bank holding loans to risky small businesses. That approach cannot be generating the right messages either for the bank, the supervisor, or the market. The true capital needs of an institution can be determined only from the risk characteristics of its balance sheet and its other exposures. That must be true not only for internal management purposes but also for the purposes of regulation.

Will Capital Levels Fall?

A common concern is that the use of credit risk models will lead to lower overall capital levels in banks. That need not occur. Under the market risk guidelines, for example, the output of the banks' models is multiplied by a factor to produce the required degree of conservatism for regulatory purposes. That approach, or some variant of it, could be adopted in any future approach applied to credit models. Alternatively, the use of capital estimates derived from internal models, combined with a capital floor determined by some simpler regulatory-based methodology, could also be considered.

It is worth noting, in this context, that tentative estimates of possible capital requirements flowing from the use of credit models have been made by a number of Australian banks. Using some quite conservative assumptions, the results point to credit risk capital requirements of around half of those required under the existing arrangements. However, when estimates of possible operational risks are taken into account (Australian banks are also attempting to quantify this component of risk as part of the risk mapping exercises being carried out within the institutions), then the resulting overall capital figure increases again to something not greatly different from the present requirement. This might suggest the need for any new capital adequacy arrangement to reach more broadly than just credit risk, perhaps into the area of operational risk. Possibly the time has come to develop an even broader approach encapsulating all forms of measurable risk. Although this would add greatly to the complexity of the regulatory development task, it would be consistent with the trend observed in banks to look in an integrated way at the broad range of risks being faced as a result of their activities.

Other Possibilities

To the extent that the simplicity of the present capital structure is seen as desirable, there may be merit in contemplating an extension to the risk grading system built into the current arrangements. It is possible to envisage the risk weighting scale extended from the current five grades to a higher number (say, ten), thereby providing greater demarcation between gradings. Movement in this direction has already occurred to some extent through the introduction of concessional risk weightings under the market risk (standard method) guidelines. This might deliver a closer alignment of regulatory capital rules with more "economic-based" measures of risk. While possible, this approach would not align with broader portfolio modeling approaches where the impact of a single counterparty on a bank's overall credit risk might differ depending on the structure of the portfolio itself. Such portfolio-based approaches would raise challenges for any supervisory system that continued to measure credit risk on the basis of fixed risk gradings. Perhaps more importantly, to the extent that internal models are viewed as the appropriate long-term approach to capital adequacy, it may be best to avoid "band-aid" solutions that could divert attention from the ultimate goal. The simplified approach may have some relevance, however, for the less sophisticated of the banks and those with simpler balance sheets. Whatever new arrangements were introduced, there would still be a need for a simpler alternative for the less advanced banks.

There may also be merit in exploring, for application in the area of credit risk, some of the ideas developed over recent years by Kupiec and O'Brien in relation to "precommitment." The precommitment proposal is targeted at the calculation of a capital charge for traded market risk. A bank commits to a maximum loss over a fixed period and allocates capital to cover the exposure. The bank is given incentives to set realistic, and sufficiently conservative, capital charges—incentives that take the form of penalties if a bank's losses exceed its committed capital. It would avoid the need for supervisors to preordain a fixed methodology for measuring risk—with the appropriateness of any bank estimates of risk and loss determined solely by results. In theory, this broad approach could be applied to any form of risk.

It is not at all clear how this approach could translate to the area of credit risk (the authors see its application largely to the area of market risk). Whereas a bank could be assessed on a precommitment model designed to cover market risk at regular intervals (quarterly, for example), that would not be possible where credit risk is involved since the nature of credit cycles is such that true tests come only infrequently (that is, over a full economic or banking cycle). When problems do arise, they have the potential to be serious events. There would have to be serious doubts about the credibility of any approach that is based on the application of sanctions where losses involved might be very significant or even institution-threatening.

Nevertheless, the idea of a system based on the concept of banks committing to a certain level of capital, with supervisors avoiding the need to attempt a complex standardisation of rules and parameters surrounding credit models, is an attractive thought and worth exploring.

Disclosure-Based Approaches

Much of the discussion above assumes the ongoing presence of a capital-based regulatory regime. Another quite different and more radical approach is also worthy of mention. It would involve stepping away completely from any formal determination of capital requirements and insisting upon much greater disclosure by banks, allowing the market to determine the relative degrees of safety attached to the different institutions. This thought process lies behind the current regulatory regime in New Zealand (though it should be noted that the supervisory authority in that country has, in fact, retained much of the traditional supervisory and capital adequacy structure).

In a disclosure-based approach, banks would be required to provide detailed information on their measurements of credit risk, the methodologies used to derive the estimates, capital holdings, and any other data or information relevant to interested parties. To the extent that a bank stepped out of line with established banking norms, these external parties would go elsewhere or demand changes within the institution, the result being that the institution would either go broke or be forced to comply with market expectations, whether they be in relation to capital, risk levels, liquidity arrangements, management structure, or something else.

There is a very strong case to be made favouring greater market discipline on the banking sector, and supervisors, internationally, have been at the forefront of the debate on disclosure. The issue, however, is not about the merits of improved banking disclosure as such (about which there is little debate), but the extent to which disclosure could form a realistic alternative to the more traditional capital-based approach.

Ultimately, it is a philosophical judgment as to whether market-based approaches might work or whether the health and safety of the banking sector are considered too important to leave entirely to the market. The latter is the mainstream view and one that is likely to be maintained. Acceptance of this position in no way reduces the importance of improved disclosure of financial information by institutions.

V. Assessment and Conclusions

There is no definitive answer to the question of how capital adequacy arrangements, or indeed supervisory arrangements more broadly defined, should evolve in the future. The emphasis on risk-based capital adequacy as the basis for supervision in the industrialised world is now firmly established and seems unlikely to change in the foreseeable future.

The option of leaving the current arrangement in place in its present form (or with some minor modifications) may be realistic as far as most banks are concerned. However, the activities of the leading banks are pushing regulatory arrangements in the direction of greater sophistication of credit risk measurement (just as they did in the case of market risk measurement). Credit modeling is still in an early phase of development in the Australian market and it would be unrealistic to believe that a regime based on that approach is viable in the short term. However, developments are occurring quickly and credit modeling will become much more significant for banks in the medium term. Very importantly, growing competition in the provision of financial services may be increasing the competitive disadvantages associated with existing arrangements.

As supervisors of the Australian banking system, we are keen to see the supervisory structure evolve with the market. Without trying to downplay the complexities that will be involved, we believe there is a strong case to commit to the development of an approach to capital adequacy that utilises better measures of credit risk and portfolio modeling techniques. Over the longer term, more integrated approaches to risk measurement (for example, embodying credit, market, and operational risk) may need to be the goal. Looking specifically at credit risk modeling, there is reason to believe that a relatively large number of Australian banks would in time see themselves as potential model users. The work currently being done by the major banks in Australia provides grounds for a belief that internally based models could be a feasible option for that group. Even for the smaller regional banks, with a high proportion of residential housing on their balance sheets, it would be a relatively simple task to model credit risk, given the stability of residential housing default and loss rates in Australia over a long period (this is one of the few reliable long-term statistics available in this market).

How soon might all this occur? Realistically, it may be some years before credit risk modeling becomes feasible in the Australian system, and longer than that for more sophisticated approaches that attempt to integrate different forms of risk within a single framework. However, developments are occurring rapidly in the banking system and it is also the case that supervisory arrangements have evolved in recent years and supervisors (as a group) are now technically better equipped to deal with complex issues, such as credit modeling, than they were a decade ago. Together, these factors may bring the respective time frames forward.

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Portfolio Credit Risk

Thomas C. Wilson

Introduction and Summary

Financial institutions are increasingly measuring and managing the risk from credit exposures at the portfolio level, in addition to the transaction level. This change in perspective has occurred for a number of reasons. First is the recognition that the traditional binary classification of credits into "good" credits and "bad" credits is not sufficient—a precondition for managing credit risk at the portfolio level is the recognition that all credits can potentially become "bad" over time given a particular economic scenario. The second reason is the declining profitability of traditional credit products, implying little room for error in terms of the selection and pricing of individual transactions, or for portfolio decisions, where diversification and timing effects increasingly mean the difference between profit and loss. Finally, management has more opportunities to manage exposure proactively after it has been originated, with the increased liquidity in the secondary loan market, the increased importance of syndicated lending, the availability of credit derivatives and third-party guarantees, and so on.

In order to take advantage of credit portfolio management opportunities, however, management must first answer several technical questions: What is the risk of a given portfolio? How do different macroeconomic scenarios, at both the regional and the industry sector level, affect the portfolio's risk profile? What is the effect of changing the portfolio mix? How might risk-based pricing at the individual contract and the portfolio level be influenced by the level of expected losses and credit risk capital?

This paper describes a new and intuitive method for answering these technical questions by tabulating the exact loss distribution arising from correlated credit events for any arbitrary portfolio of counterparty exposures, down to the individual contract level, with the losses measured on a marked-to-market basis that explicitly recognises the potential impact of defaults and credit migrations.[1] The importance of tabulating the exact loss distribution is highlighted by the fact that counterparty defaults and rating migrations cannot be predicted with perfect foresight and are not perfectly correlated, implying that management faces a distribution of potential losses rather than a single potential loss. In order to define credit risk more precisely in the context of loss distributions, the financial industry is converging on risk measures that summarise management-relevant aspects of the entire loss distribu-

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tion. Two distributional statistics are becoming increasingly relevant for measuring credit risk: expected losses and a critical value of the loss distribution, often defined as the portfolio's credit risk capital (CRC). Each of these serves a distinct and useful role in supporting management decision making and control (Exhibit 1).

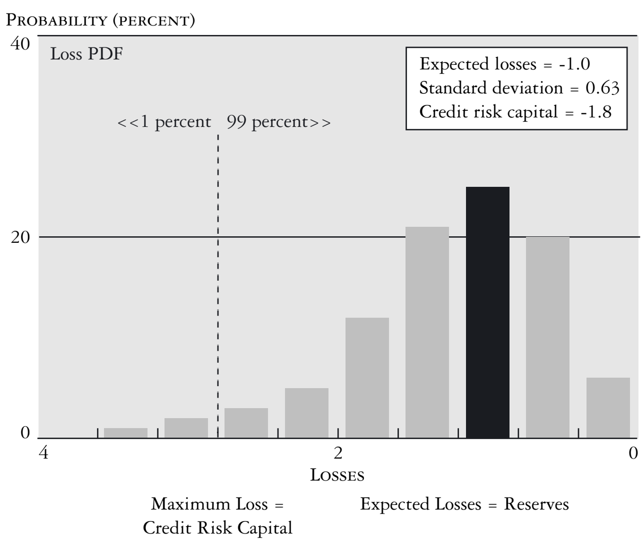
Expected losses, illustrated as the mean of the distribution, often serve as the basis for management's reserve policies: the higher the expected losses, the higher the reserves required. As such, expected losses are also an important component in determining whether the pricing of the credit-risky position is adequate: normally, each transaction should be priced with sufficient margin to cover its contribution to the portfolio's expected credit losses, as well as other operating expenses.

Credit risk capital, defined as the maximum loss within a known confidence interval (for example, 99 percent) over an orderly liquidation period, is often interpreted as the additional economic capital that must be held against a given portfolio, above and beyond the level of credit reserves, in order to cover its unexpected credit losses. Since it would be uneconomic to hold capital against *all* potential losses (this would imply that equity is held against 100 percent of all credit exposures), some level of capital must be chosen to support the portfolio of transactions in most, but not all, cases. As with expected losses, CRC also plays an important role in determining whether the credit risk of a particular transaction is appropriately priced: typically, each transaction should be priced with sufficient margin to cover not only its expected losses, but also the cost of its marginal risk capital contribution.

Exhibit 1

LOSS DISTRIBUTION

$100 Portfolio, 250 Equal and Independent Credits with Default Probability Equal to 1 Percent



In order to tabulate these loss distributions, most industry professionals split the challenge of credit risk measurement into two questions: First, what is the joint probability of a credit event occurring? And second, what would be the loss should such an event occur?

In terms of the latter question, measuring potential losses given a credit event is a straightforward exercise for many standard commercial banking products. The exposure of a $100 million unsecured loan, for example, is roughly $100 million, subject to any recoveries. For derivatives portfolios or committed but unutilised lines of credit, however, answering this question is more difficult. In this paper, we focus on the former question, that is, how to model the joint probability of defaults across a portfolio. Those interested in the complexities of exposure measurement for derivative and commercial banking products are referred to J.P. Morgan (1997), Lawrence (1995), and Rowe (1995).

The approach developed here for measuring expected and unexpected losses differs from other approaches in several important respects. First, it models the actual, discrete loss distribution, depending on the number and size of credits, as opposed to using a normal distribution or mean-variance approximations. This is important because with one large exposure the portfolio's loss distribution is discrete and bimodal, as opposed to continuous and unimodal; it is highly skewed, as opposed to symmetric; and finally, its shape changes dramatically as other positions are added. Because of this, the typical measure of unexpected losses used, standard deviations, is like a "rubber ruler": it can be used to give a sense of the uncertainty of loss, but its actual interpretation in terms of dollars at risk depends on the degree to which the ruler has been "stretched" by diversification or large exposure effects. In contrast, the model developed here explicitly tabulates the actual, discrete loss distribution for any given portfolio, thus also allowing explicit and accurate tabulation of a "large exposure premium" in terms of the risk-adjusted capital needed to support less-diversified portfolios.

Second, the losses (or gains) are measured on a default/no-default basis for credit exposures that *cannot* be liquidated (for example, most loans or over-the-counter trading exposure lines) as well as on a theoretical marked-to-market basis for those that *can* be liquidated prior to the maximum maturity of the exposure. In addition, the distribution of average write-offs for retail portfolios is also modeled. This implies that the approach can integrate the credit risk arising from liquid secondary market positions and illiquid commercial positions, as well as retail portfolios such as mortgages and overdrafts. Since most banks are active in all three of these asset classes, this integration is an important first step in determining the institution's overall capital adequacy.

Third, and most importantly, the tabulated loss distributions are driven by the state of the economy, rather than based on unconditional or twenty-year averages that do not reflect the portfolio's true current risk. This allows the model to capture the cyclical default effects that determine the lion's share of the risk for diversified portfolios. Our research shows that the bulk of the systematic or nondiversifiable risk of any portfolio can be "explained" by the economic cycle. Leveraging this fact is not only intuitive, but it also leads to powerful management insights on the true risk of a portfolio.

Finally, specific country and industry influences are explicitly recognised using empirical relationships, which enable the model to mimic the actual default correlations between industries and regions at the transaction and the portfolio level. Other models, including many developed in-house, rely on a single systematic risk factor to capture default correlations; our approach is based on a true multi-factor systematic risk model, which reflects reality better.

The model itself, described in greater detail in McKinsey (1998) and Wilson (1997a, 1997b), consists of two important components, each of which is discussed in greater detail below. The first is a *multi-factor model of systematic default risk*. This model is used to simulate jointly the conditional, correlated, average default, and credit migration probabilities for each individual country/industry/rating segment. These average segment default probabilities are made conditional on the current state of the economy and incorporate industry sensitivities (for example, "high-beta" industries such as construction react more to cyclical changes) based on aggregate historical relationships. The second is a method for tabulating the discrete loss distribution for any portfolio of credit exposures—liquid and nonliquid, constant and nonconstant, diversified and nondiversified. This is achieved by convoluting the conditional, marginal loss distributions of the individual positions to develop the aggregate loss distribution, with default correlations between different counterparties determined by the systematic risk driving the correlated average default rates.

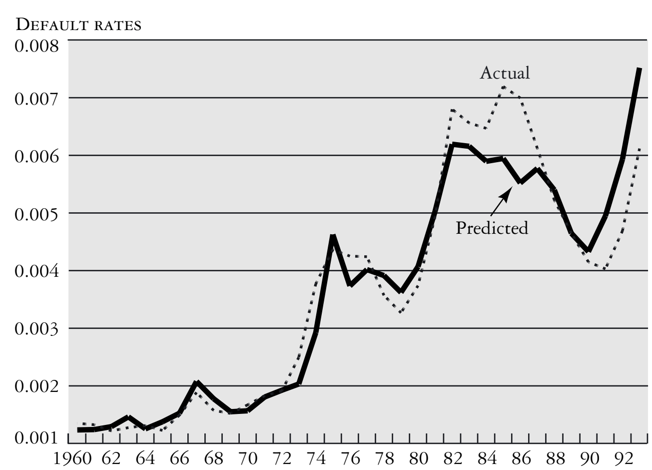
Systematic Risk Model

In developing this model for systematic or nondiversifiable credit risk, we leveraged five intuitive observations that credit professionals very often take for granted.

First, that diversification helps to reduce loss uncertainty, all else being equal. Second, that substantial systematic or nondiversifiable risk nonetheless remains for even the most diversified portfolios. This second observation is illustrated by the "Actual" line plotted in Exhibit 2, which represents the average default rate for all German corporations over the

Exhibit 2

Actual versus Predicted Default Rates
Germany



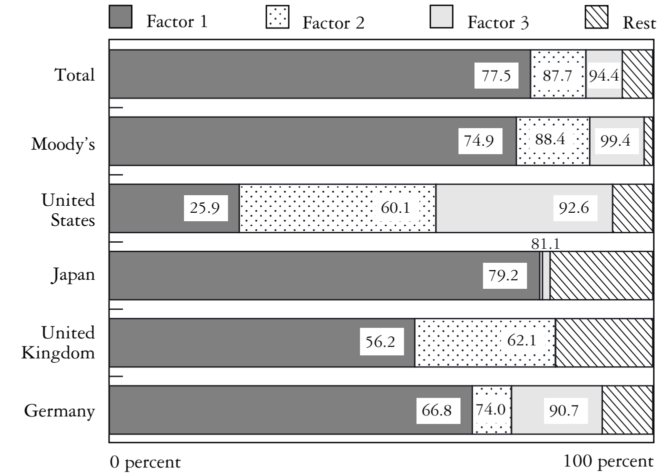
1960-94 period; the variation or volatility of this series can be interpreted as the systematic or nondiversifiable risk of the "German" economy, arguably a very diversified portfolio. Third, that this systematic portfolio risk is driven largely by the "health" of the macroeconomy—in recessions, one expects defaults to increase.

The relationship between changes in average default rates and the state of the macroeconomy is also illustrated in Exhibit 2, which plots the actual default rate for the German economy against the predicted default rate, with the prediction equation based solely upon macroeconomic aggregates such as GDP growth and unemployment rates. As the exhibit shows, the macroeconomic factors explain much of the overall variation in the average default rate series, reflected in the regression equation's R^2 of more than 90 percent for most of the countries investigated (for example, Germany, the United States, the United Kingdom, Japan, Switzerland, Spain, Sweden, Belgium, and France). The fourth observation is that different sectors of the economy react differently to macroeconomic shocks, albeit with different economic drivers: U.S. corporate insolvency rates are heavily influenced by interest rates, the Swedish paper and pulp industry by the real terms of trade, and retail mortgages by house prices and regional economic indicators. While all of these examples are intuitive, it is sometimes surprising how strong our intuition is when put to statistical tests. For example, the intuitive expectation that the construction sector would be more adversely affected during a recession than most other sectors is supported by the data for all of the different countries analysed.

Exhibit 3 illustrates the need for a multi-factor model, as opposed to a single-factor model, for systematic risk. Performing a principal-components analysis of the country average default rates, a good surrogate for systematic risk by country, it emerges that the first "factor" captures only 77.5 percent of the total variation in systematic default rates for Moody's and the U.S., U.K., Japanese, and German markets. This corresponds to the amount of systematic risk "captured" by most single-factor models; the rest of the variation is implicitly assumed to be independent and uncorrelated. Unfortunately, the first factor explains only 23.9 percent of the U.S. systematic risk index, 56.2 percent for the United Kingdom, and 66.8 percent for Germany. The exhibit demonstrates that the substantial correlation remaining is explained by the second and third factors, explaining an additional 10.2 percent and 6.8 percent, respectively, of the total variation and the bulk of the risk for the United States, the United Kingdom, and Germany. This demonstrates that a single-factor systematic risk model like one based on asset betas or aggregate Moody's/Standard and Poor's data alone is not sufficient to capture all correlations accurately. The final observation is also both intuitive and empirically verifiable: that rating migrations are also linked to the macroeconomy—not only is default more likely during a recession, but credit downgrades are also more likely.

Exhibit 3

Total Systematic Risk Explained



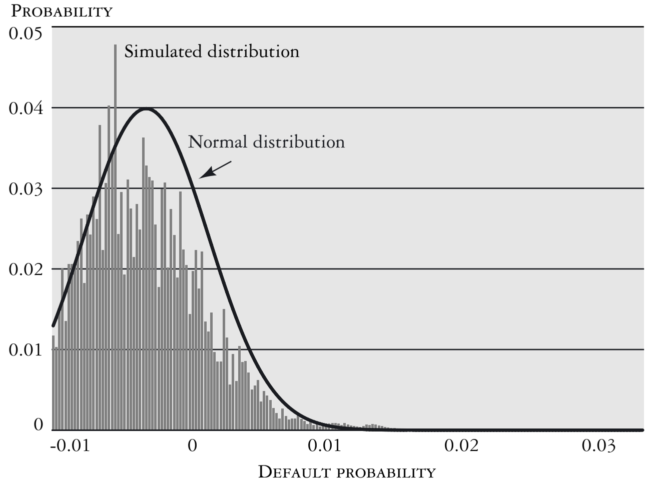
Note: The factor 2 band for Japan is 79.7; the factor 3 band for the United Kingdom is 82.1.

When we formulate each of these intuitive observations into a rigorous statistical model that we can estimate, the net result is a multi-factor statistical model for systematic credit risk that we can then simulate for every country/industry/rating segment in our sample. This is demonstrated in Exhibit 4, where we plot the simulated cumulative default rates for a German, single-A-rated, five-year exposure based on current economic conditions in Germany.

Exhibit 4

SIMULATED DEFAULT PROBABILITIES

Germany, Single-A-Rated Five-Year Cumulative Default Probability



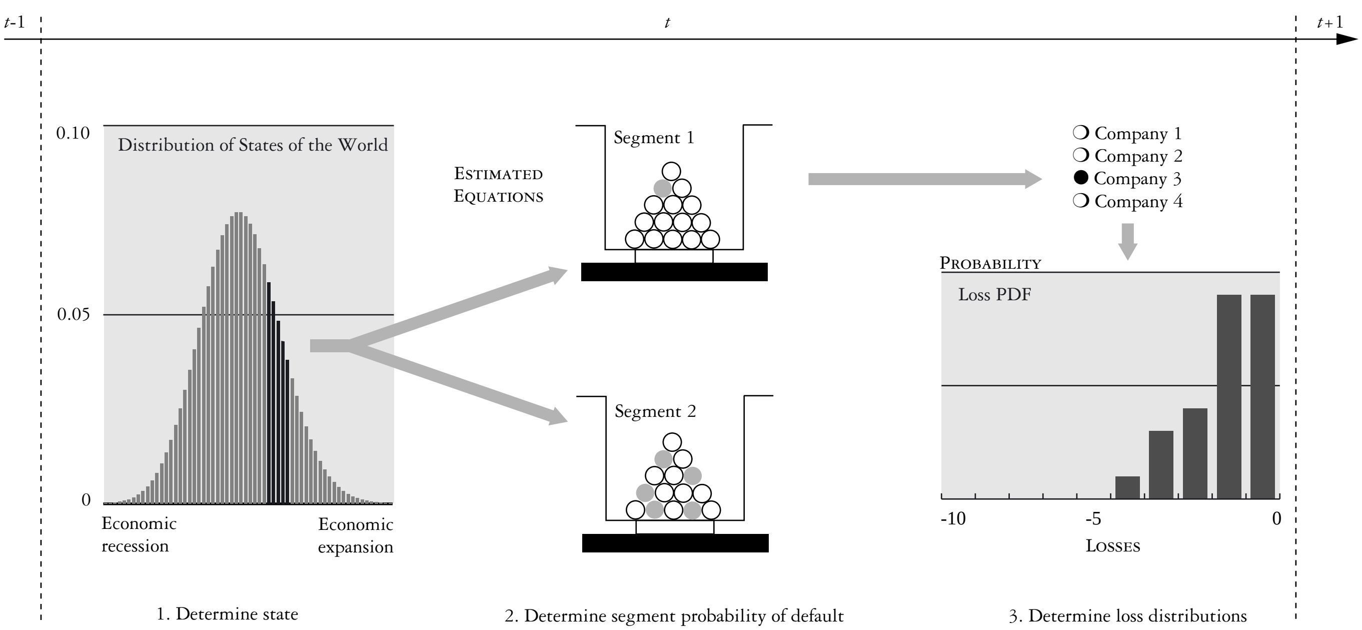
LOSS TABULATION METHODS

While these distributions of correlated, average default probabilities by country, sector, rating, and maturity are interesting, we still need a method of explicitly tabulating the loss distribution for any arbitrary portfolio of credit risk exposures. So we now turn to developing an efficient method for tabulating the loss distribution for any arbitrary portfolio, capable of handling portfolios with large, undiversified positions and/or diversified portfolios; portfolios with nonconstant exposures, such as those found in derivatives trading books, and/or constant exposures, such as those found in commercial lending books; and portfolios comprising liquid, credit-risky positions, such as secondary market debt, or loans and/or illiquid exposures that must be held to maturity, such as some commercial loans or trading lines. Below, we demonstrate how to tabulate the loss distributions for the simplest case (for example, constant exposures, nondiscounted losses) and then build upon the simplest case to handle more complex cases (for example, nonconstant exposures, discounted losses, liquid positions, and retail portfolios). Exhibit 5 provides an abstract timeline for tabulating the overall portfolio loss distribution. The first two steps relate to the systematic risk model and the third represents loss tabulations.

Time is divided into discrete periods, indexed by t. During each period, a sequence of three steps occurs: first, the state of the economy is determined by simulation; second, the conditional migration and cumulative default probabilities for each country/industry segment

Exhibit 5

MODEL STRUCTURE



are determined based on the equations estimated earlier; and, finally, the actual defaults for the portfolio are determined by sampling from the relevant distribution of segment-specific simulated default rates. Exhibit 6 gives figures for the highly stylised single-period, two-segment numerical example described below.

1. *Determine the state*: For any given period, the first step is to determine the state of the world, that is, the health of the macroeconomy. In this simple example, three possible states of the economy can occur: an economic "expansion" (with GDP growth of +1 percent), an "average" year (with GDP growth of 0 percent), and an economic "recession" (with GDP growth of -1 percent). Each of these states can occur with equal probability (33.33 percent) in this numerical sample.

2. *Determine segment probability of default*: The second step is to then translate the state of the world into conditional probabilities of default for each customer segment based on the estimated relationships described earlier. In this example, there are two counterparty segments, a "low-beta" segment, whose probability of default reacts less strongly to macroeconomic fluctuations (with a range of 2.50 percent to 4.71 percent), and a "high-beta" segment, which reacts quite strongly to macroeconomic fluctuations (with a range of 0.75 percent to 5.25 percent).

3. *Determine loss distributions*: We now tabulate the (nondiscounted) loss distribution for portfolios that are constant over their life, cannot be liquidated, and have known recovery rates, including both diversified and non-diversified positions. Later, we relax each of these assumptions within the framework of this model in order to estimate more accurately the expected losses and risk capital from credit events.

Exhibit 6

NUMERICAL EXAMPLE

1. Determine state	State	GDP	Probability of Default (Percent)	
	Expansion	+1	33.33	
	Average	0	33.33	
	Recession	-1	33.33	
2. Determine segment probability of default	**State**		**Low-Beta Probability of Default A (Percent)**	**High-Beta Probability of Default B (Percent)**
	Expansion		2.50	0.75
	Average		2.97	3.45
	Recession		4.71	5.25
3. Determine loss distributions				

The conditional loss distribution in the simple two-counterparty, three-state numerical example is tabulated by recognising that there are three independent "draws," or states of the economy and that, conditional on each of these states, there are only four possible default scenarios: A defaults, B defaults, A+B defaults, or no one defaults (Exhibit 7).

The conditional probability of each of these loss events for each state of the economy is calculated by convoluting each position's individual loss distribution for each state. Thus, the conditional probability of a $200 loss in the expansion state is 0.01 percent, whereas the unconditional probability of achieving the same loss given the entire distribution of future economic states (expansion, average, recession) is 0.1 percent after rounding errors. For this example, the expected portfolio loss is $6.50 and the credit risk capital is $100, since this is the maximum potential loss within a 99 percent confidence interval across all possible future states of the economy.

Our calculation method is based on the assumption that all default correlations are caused by the correlated segment-specific default indices. That is, no further information beyond country, industry, rating, and the state of the economy is useful in terms of predicting the default correlation between any two counterparties. To underscore this point, suppose that management is confronted with two single-A-rated counterparties in the German construction industry with the prospect of either a recession or an economic expansion in the near future. Using the traditional approach, which ignores the impact of the economy in determining default probabilities, we would conclude that the counterparty default rates were correlated. Using our approach, we observe that, in a recession, the probability of default for both counterparties is significantly higher than during an expansion and that their joint conditional probability of default is therefore also higher, leading to correlated defaults. However, because we assume that all idiosyncratic or nonsystematic risks can be diversified away, no other information beyond the counterparties' country, industry, and rating (for example, the counterparties' segmentation criteria) is useful in determining their joint default correlation. This assumption is made implicitly by other models, but ours extends the standard single-factor approach to a multi-factor approach that better captures country- and industry-specific shocks.

Intuitively, we should be able to diversify away all idiosyncratic risk, leaving only systematic, nondiversifiable risk. More succinctly, as we diversify our holdings within a particular segment, that segment's loss distribution will converge to the loss distribution implied by the segment index. This logic is consistent with other single- or multi-factor models in finance, such as the capital asset pricing model.

Our multi-factor model for systematic default risks is qualitatively similar, except that there is no single risk factor. Rather, there are multiple factors that fully describe the complex correlation structure between countries, industries, and ratings. In our simple numerical example, for a well-diversified portfolio consisting of a large number of counterparties in each segment (the NA & NB = Infinity case), all idiosyncratic risk per segment is diversified away, leaving only the systematic risk per segment (Exhibit 8).

In other words, because of the law of large numbers, the actual loss distribution for the portfolio will converge to the expected loss for each state of the world, implying that the unconditional loss distribution has only three possible outcomes, representing each of the three states of the world, each occurring with equal probability and with a loss per segment consistent with the conditional probability of loss for that segment given that state of the economy. While the expected losses from the portfolio would remain constant, this remaining systematic risk would generate a CRC value of only \$9.96 for the \$200 million exposure in this simple example, demonstrating both the benefit to be derived from portfolio diversification and the fact that not all systematic risk can be diversified away.

In the second case (labeled NA = 1 & NB = Infinity), all of the idiosyncratic risk is diversified away within segment B, leaving only the systematic risk component for segment B. The segment A position, however, still contains idiosyncratic risk, since it comprises only a single risk position. Thus, for each state of the economy, two outcomes

Exhibit 7

NUMERICAL EXAMPLE: TWO EXPOSURES

1. Determine state
2. Determine segment probability of default
3. Determine loss distributions

	Expansion				Average				Recession			
Loss Distribution	A	B	A+B	Probability of Default (Percent)	A	B	A+B	Probability of Default (Percent)	A	B	A+B	Probability of Default (Percent)
	-100	-100	-200	0.01	-100	-100	-200	0.03	-100	-100	-200	0.08
	-100	0	-100	0.83	-100	0	-100	0.96	-100	0	-100	1.49
	0	-100	-100	0.24	0	-100	-100	1.12	0	-100	-100	1.67
	0	0	0	32.36	0	0	0	31.23	0	0	0	30.10
	Correlation (A,B) = 0 percent				Correlation (A,B) = 0 percent				Correlation (A,B) = 0 percent			

Conditional correlation (A,B) = 1 percent

PROBABILITY OF LOSS EVENT

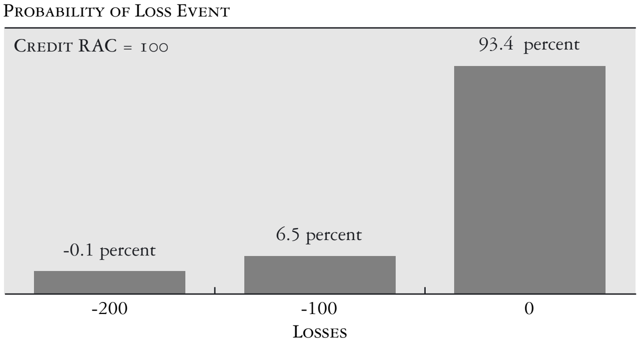


Exhibit 8

NUMERICAL EXAMPLE: DIVERSIFIED EXPOSURES

1. Determine state
2. Determine segment probability of default
3. Determine loss distributions

NA & NB = Infinity

	Loss A	Loss B	Loss A+B	Probability of Default (Percent)
Expansion	-2.50	-0.75	-3.25	33.33
Average	-2.97	-3.45	-6.42	33.33
Recession	-4.71	-5.25	-9.96	33.33
	Unconditional correlation (A, B)			91.00
	Credit RAC = 9.96			

NA =1 & NB = Infinity

	Loss A	Loss B	Loss A+B	Probability of Default (Percent)
Expansion	-100	-0.75	-100.75	0.83
	0	-0.75	-0.75	32.50
Average	-100	-3.45	-103.45	0.99
	0	-3.45	-3.45	32.30
Recession	-100	-5.25	-105.25	1.57
	0	-5.25	-5.25	31.80
	Credit RAC = 105.25			

are possible: either the counterparty in segment A goes bankrupt or it does not; the unconditional probability that counterparty A will default in the economic expansion state is 0.83 percent (33.33 percent probability that the expansion state occurs multiplied by a 2.5 percent probability of default for a segment A counterparty given that state). Regardless of whether or not counterparty A goes into default, the segment B position losses will be known with certainty, given the state of the economy, since all idiosyncratic risk within that segment has been diversified away.

To illustrate the results using our simulation model, suppose that we had equal $100, ten-year exposures to single-A-rated counterparties in each of five country segments—Germany, France, Spain, the United States, and the United Kingdom—at the beginning of 1996. The aggregate simulated loss distribution for this portfolio of diversified country positions, conditional on the then-current macroeconomic scenarios for the different countries at the end of 1995, is given in the left panel of Exhibit 9.

The impact of introducing one large, undiversified exposure into the same portfolio is illustrated in the right panel of Exhibit 9. Here, we take the same five-country portfolio of diversified index positions used in the left panel, but add a single, large, undiversified position to the "other" country's position.

The impact of this new, large concentration risk is clear. The loss distribution becomes "bimodal," reflecting the fact that, for each state of the world, two events might occur: either the large counterparty will go bankrupt, generating a "cloud" of portfolio loss events centered around -140, or the undiversified position will not go bankrupt, generating a similar cloud of loss events centered around -40, but with higher probability. This risk concentration disproportionately increases the amount of risk capital needed to support the portfolio from $61.6 to $140.2, thereby demonstrating the large-exposure risk capital premium needed to support the addition of large, undiversified exposures.

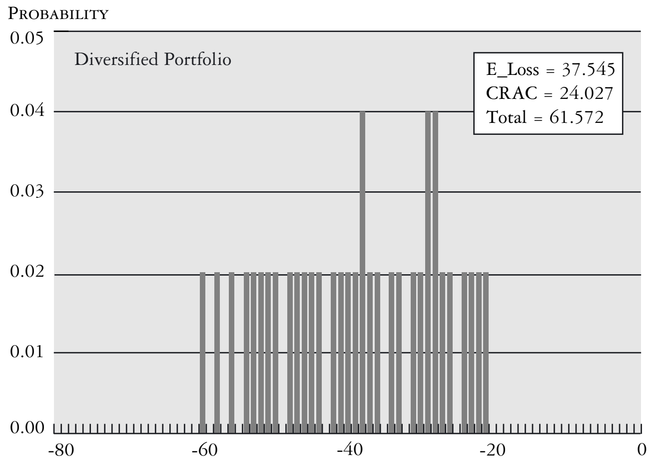
The calculations above illustrate how to tabulate the (nondiscounted) loss distributions for nonliquid portfolios with constant exposures. While useful in many instances, these portfolio characteristics differ from reality in two important ways. First, the potential exposure profiles generated by trading products are typically not constant (as pointed out by Lawrence [1995] and Rowe [1995]). Second, the calculations ignore the time value of money, so that a potential loss in the future is somehow "less painful" in terms of today's value than a loss today.

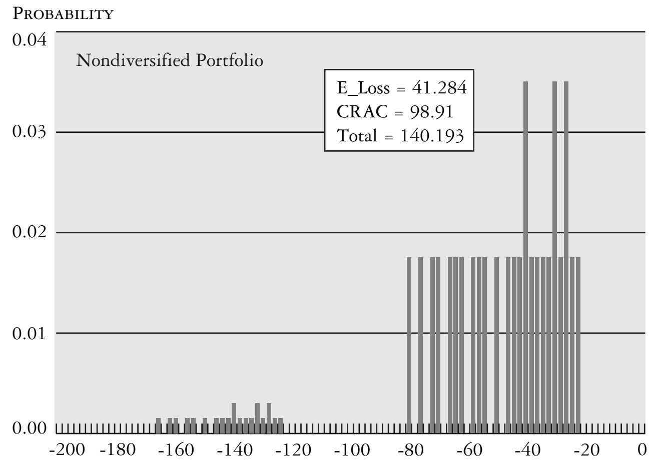
In reality, the amount of potential economic loss in the event of default varies over time, due to discounting, or nonconstant exposures, or both. This can be seen in Exhibit 10. If the counterparty were to go into default sometime during the second year, the present value of the portfolio's loss would be $50 in the case of nonconstant exposures and $\$100 * e(-r_2 * 2)$ in the case of discounted exposures, as opposed to $100 and $\$100 * e(-r_1 * 1)$ if the counterparty had gone into default sometime during the first year. Unlike the case of constant, nondiscounted exposures, where the timing of the default is inconsequential, nonconstant exposures or discounting of the losses implies that the timing of the default is critical for tabulating the economic loss.

Exhibit 9

EXAMPLES OF PORTFOLIO LOSS DISTRIBUTIONS

Portfolio Loss Distribution





Note: Business unit, book, country, rating, maturity, exposure.

Addressing both of these issues requires us to work with *marginal*, as opposed to *cumulative*, default probabilities. Whereas the cumulative default probability is the aggregate probability of observing a default in *any* of the previous years, the marginal default probability is the probability of observing a loss in each specific year, given that the default has not already occurred in a previous period.

Exhibit 11 illustrates the impact of nonconstant loss exposures in terms of tabulating loss distributions. With constant, nondiscounted exposures, the loss distribution for a single exposure is bimodal. Either it goes into default at some time during its maturity, with a cumulative default probability covering the entire three-year period equal to $p_1 + p_2 + p_3$ in the exhibit, implying a loss of 100, or it does not. If the exposure is nonconstant, however, you stand to lose a different amount depending upon the exact timing of the default event. In the above example, you would lose 100 with probability p_1, the marginal probability that the counterparty goes into default during the first year; 50 with probability p_2, the marginal probability that the counterparty goes into default during the second year; and so on.

So far, we have been simulating only the cumulative default probabilities. Tabulating the marginal default probabilities from the cumulative is a straightforward exercise. Once this has been done, the portfolio loss distribution can be tabulated by convoluting the individual loss distributions, as described earlier. The primary difference between our model and other models is that we explicitly recognise that loss distributions for nonconstant exposure profiles are not binomial but multinomial, recognising the fact that the timing of default is also important in terms of tabulating the position's marginal loss distribution.

Exhibit 10

NONCONSTANT OR DISCOUNTED EXPOSURES

	Exposure Loss Profile	
Credit Event Tree	Nonconstant	Discounted[a]
No default		
Default, year three	25	100*e(-r_3*3)
Default, year two	50	100*e(-r_2*2)
Default, year one	100	100*e(-r_1*1)

[a]r_1 is the continuously compounded, per annum zero coupon discount rate.

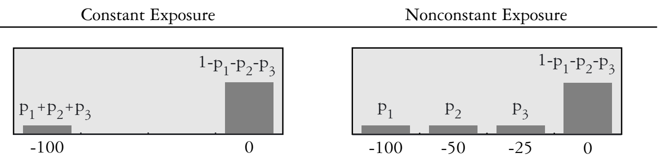
LIQUID OR TRADABLE POSITIONS AND/OR ONE-YEAR MEASUREMENT HORIZONS

So far, we have also assumed that the counterparty exposure must be held until maturity and that it cannot be liquidated at a "fair" price prior to maturity; under such

Exhibit 11

NONCONSTANT OR DISCOUNTED EXPOSURES

	Exposure Profile	
Credit Event Tree	Nonconstant	Constant
No default $1\text{-}p_1\text{-}p_2\text{-}p_3$	0	0
Default, year three p_3	25	100
Default, year two p_2	50	100
Default, year one p_1	100	100



circumstances, allocating capital and reserves to cover potential losses over the life of the asset may make sense. Such circumstances often arise in intransparent segments where the market may perceive the originator of the credit to have superior information, thereby reducing the market price below the underwriter's perceived "fair" value. For some other asset classes, however, this assumption is inadequate for two reasons:

- Many financial institutions are faced with the increasing probability that a bond name will also show up in their loan portfolio. So they want to measure the credit risk contribution arising from their secondary bond trading operations and integrate it into an overall credit portfolio perspective.
- Liquid secondary markets are emerging, especially in the rated corporate segments.

In both cases, management is presented with two specific measurement challenges. First, as when measuring market risk capital or value at risk, management must decide on the appropriate time horizon over which to measure the potential loss distribution. In the previous illiquid asset class examples, the relevant time horizon coincided with the maximum maturity of the exposure, based on the assumption that management could not liquidate the position prior to its expiration. As markets become more liquid, the appropriate time horizons may be asset-dependent and determined by the asset's orderly liquidation period.

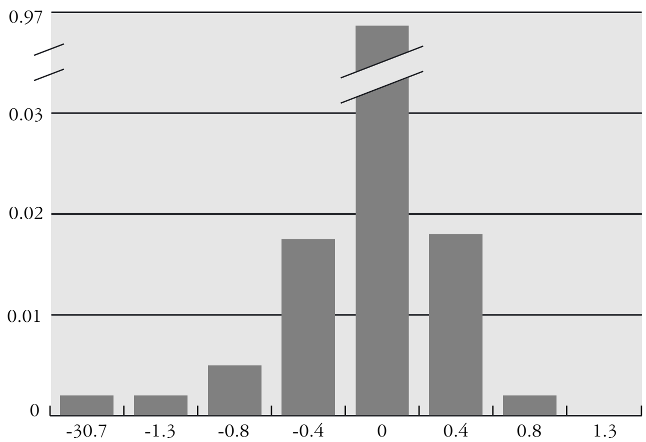
The second challenge arises in regard to tabulating the marked-to-market value losses for liquid assets should a credit event occur. So far, we have defined the loss distribution only in terms of default events (although default probabilities have been tabulated using rating migrations as well). However, it is clear that if the position can be liquidated prior to its maturity, then other credit events (such as credit downgrades and upgrades) will affect its marked-to-market value at any time prior to its ultimate maturity. For example, if you lock in a single-A-rated spread and the credit rating of the counterparty decreases to a triple-B, you suffer an economic loss, all else being equal: while the market demands a higher, triple-B-rated spread, your commitment provides only a lower, single-A-rated spread.

In order to calculate the marked-to-market loss distribution for positions that can be liquidated prior to their maturity, we therefore need to modify our approach in two important ways. First, we need not only simulate the cumulative default probabilities for each rating class, but also their migration probabilities. This is straightforward, though memory-intensive. Complicating this calculation, however, is the fact that if the time horizons are different for different asset classes, a continuum of rating migration probabilities might need to be calculated, one for each possible maturity or liquidation period. To reduce the complexity of the task, we tabulate migration probabilities for yearly intervals only and make the expedient assumption that the rating migration probabilities for any liquidation horizon that falls between years can be approximated by some interpolation rule.

Second, and more challenging, we need to be able to tabulate the change in marked-to-market value of the exposure for each possible change in credit rating. In the case of traded loans or debt, a pragmatic approach is simply to define a table of average credit spreads based on current market conditions, in basis points per annum, as a function of rating and the maturity of the underlying exposure. The potential loss (or gain) from a credit migration can then be tabulated by calculating the change in marked-to-market value of the exposure due to the changing of the discount rate implied by the credit migration.

Exhibit 12

MARKED-TO-MARKET CREDIT EVENT
PROFIT/LOSS DISTRIBUTION



The results of applying this approach are illustrated in Exhibit 12, which tabulates the potential profit and loss profile from a single traded credit exposure, originally rated triple-B, which can be liquidated prior to one year. For this example, we have used a recovery rate of 69.3 percent, a proxy for the average recovery rate for senior secured credits rated triple-B. Inspection of Exhibit 12 shows that it is inappropriate to talk about "loss distributions" in the context of marked-to-market loan or debt securities, since a profit or gain in marked-to-market value can also be created by an improvement in the counterparty's credit standing.

Although this approach allows us to capture the impact of credit migrations while holding the level of interest rates and spreads constant, it must be seen as a complement to a market risk measurement system that accurately captures the potential profit-or-loss impact of changing interest rate and average credit spread levels. If your market risk measurement system does not capture these risks, then a more complicated approach could be used, such as jointly simulating interest rate levels, average credit spread levels, and credit rating migrations.

RETAIL PORTFOLIOS

Tabulating the losses from retail mortgage, credit card, and overdraft portfolios proceeds along similar lines. However, for such portfolios, which are often characterised by large numbers of relatively small, homogeneous exposures, it is frequently expedient to simulate *directly* the average loss or write-off rate for the portfolio under different macroeconomic scenarios based on similar, estimated equations as those described earlier, rather than migration probabilities for each individual obligor. Once simulated, the loss contribution under a given macroeconomic scenario for the first year is calculated as $P_1 * LEE_1$, for the second year as $P_2 * (1 - P_1) * LEE_2$, and so on, where P_i and LEE_i are the average simulated write-off rates and loan equivalent exposures for year i, respectively.

A bank's aggregate loss distribution across its total portfolio of liquid, illiquid, and retail assets can be tabulated by applying the appropriate loss tabulation method to each asset class.

Endnote

1. This approach is embedded in CreditPortfolioView™, a software implementation of McKinsey and Company.

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Capital Allocation and Bank Management Based on the Quantification of Credit Risk

Kenji Nishiguchi, Hiroshi Kawai, and Takanori Sazaki

1. The Need for Quantification of Credit Risk

Liberalization and deregulation have recently accelerated. It is therefore useful to keep risk within a certain level in relation to capital, considering that financial institutions must control their risk appropriately to maintain the safety and soundness of their operation. In 1988, the Basle Capital Accord—International Convergence of Capital Measurement and Capital Standards—introduced a uniform framework for the implementation of risk-based capital rules. However, this framework applies the same "risk weight" (a ratio applied to assets for calculation of aggregated risk assets) to loans to all the private corporations, regardless of their creditworthiness. Such an approach might encourage banks to eliminate loans that can be terminated easily while maintaining loans with higher risk.

As shareholder-owned companies, banks are expected to maximize return on equity during this competitive era, while performing sound and safe banking functions as financial institutions with public missions. Banks are finding it useful to conduct business according to the management method that requires them to maintain risk within capital and to use risk-adjusted return on allocated capital as an index of profitability based on more accurate quantification of credit risk.

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2. Outline of the Model for the Quantification of Credit Risk

2.1. Basic Definitions for the Quantification of Credit Risk

"Credit risk" (also referred to as maximum loss), in a narrow sense, is defined as the worst expected loss (measured at a 99 percent confidence interval) that an existing portfolio (a specific group) might incur until all the assets in it mature. (We set the longest period at five years here.) Capital should cover credit risk—the maximum loss exceeding the predicted amount.

"Credit cost" (also referred to as expected loss) is defined as the loss expected within one year. Credit cost should be regarded as a component of the overall cost of the loan and accordingly be covered by the loan interest.

"Loss amount" is defined as the cumulative loss we incur over a specific time horizon because of the obligor's default. Loss amount is equal to the decrease in the present value of the cash flows related to a loan caused by setting the value of the cash flows (after the default) at zero: Loss amount equals value in consideration of default less value in case no default occurs.

Here, the loan is regarded as a bond that pays an annual fixed rate. The minimum unit period for a loan is one year; any shorter periods are to be rounded up to the nearest year. The value of each cash flow after default is zero. The discount rate can be determined only for one currency that is applied to all the transactions. Mark-to-market in case of downgrades or upgrades of credit rating is not performed. Loss amount consists of principal plus unpaid interest.

$$Loss\ amount\ =\ PV_d - PV_0\,,$$

$$PV_d = \sum_{t=1}^{d-1} D_t \bullet r \bullet P + D_d \bullet \lambda \bullet P\,,$$

$$PV_0 = \sum_{t=1}^{M} D_t \bullet r \bullet P + D_M \bullet P\,.$$

Here, d denotes the year of default, M the maturity of the loan, D_t the discount rate for year t, r the interest rate of the loan, P the outstanding balance of the loan, and λ the recovery rate. We set at zero the discount rate and the interest rate of the loan.

The above measurement does not include new lendings or rollovers that might be extended in the future. Prepayment is not considered, and the risks until the contract matures will be analyzed. (We set the longest period, however, at five years.)

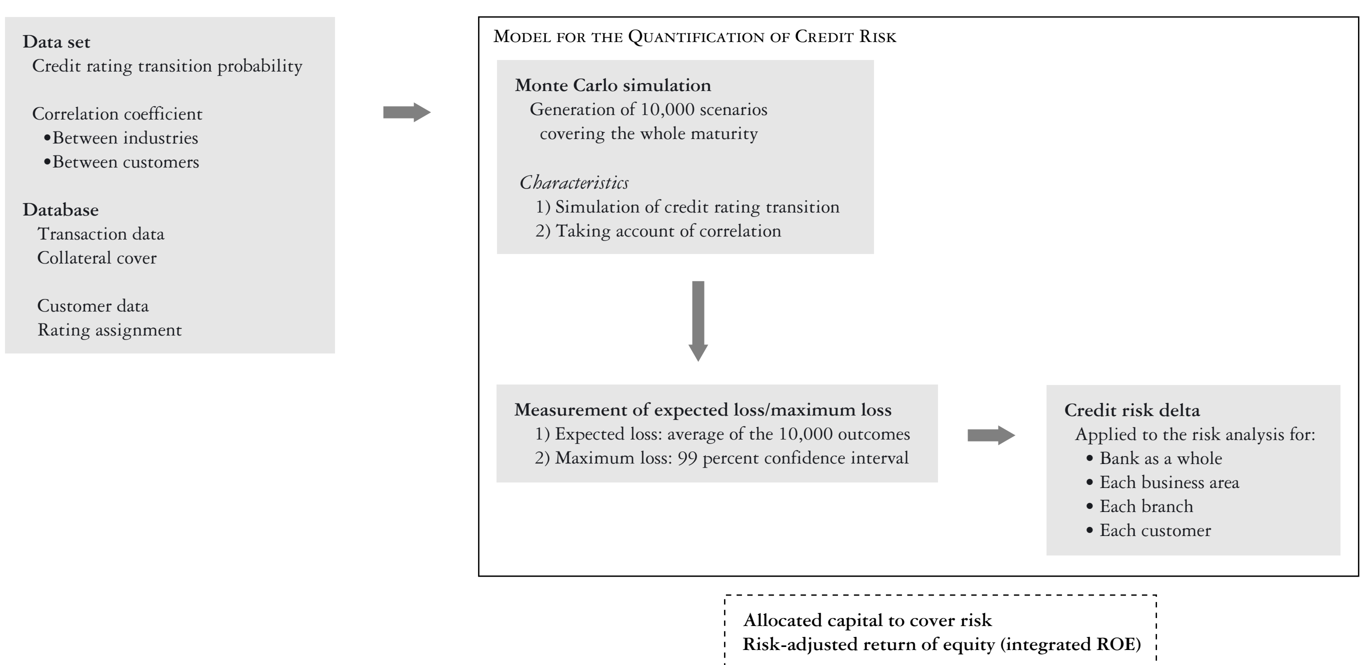
"Recovery rate" is defined as the ratio of 1) the current price of the collateral multiplied by the factors according to the internal rule to 2) the principal amount of each loan on the basis of the present perspective of recovery. In calculations of the loss amount, the amount that can be recovered is deducted from the principal amount of each loan (corresponding to $D_d \cdot \lambda \cdot P$ in the above formulas). "Uncovered balance" is loan balance less collateral coverage amount obtained by using the above recovery rate. We do not consider the fluctuation of the recovery amount in the future.

2.2. Characteristics of the Model for the Quantification of Credit Risk

First, we use Monte Carlo simulation in our model (Figure 1). When dealing with credit risk—as opposed to market risk—we must contend with a probability distribution function that is not normal. We overcome this problem

Figure 1

Fundamental Framework of the Model for the Quantification of Credit Risk



by relying on simulation approaches instead of analytical methods.

Scenarios of credit rating transition (including default) in the future for each obligor are generated through simulation. We then calculate the loss amount that we may incur for each scenario. We repeat this process 10,000 times and measure the distribution of the results. Since no distribution of profit and loss is assumed in the simulation approach, we can more precisely calculate and easily understand factors such as the average loss amounts and confidence intervals.

Second, with respect to each obligor's credit rating transition in Monte Carlo simulation, we take into account the correlation between individual obligors. Simulation in consideration of "chain default" is therefore possible, and we can generate distributions sufficiently skewed toward the loss side. This also permits the control of concentration risk—that is, the risk that exposures are concentrated in, for example, one industry.

Finally, for our model, we devise a method so that the risk amount in a particular category can be simply obtained by performing the Monte Carlo simulation for the entire portfolio, measuring the ratio of the calculated risk amount to the uncovered balance of each loan, and summing individual risks.

3. Data Set

3.1. Credit Rating Transition Matrix

"Credit rating transition matrix" is defined as a matrix that shows the probability of credit rating migration in one year, including a default case for each rating category. The probability is calculated on the basis of number of customers. A matrix is generated for each year. In this model, we obtain the mean and volatility of credit rating migration through the bootstrap (resampling) method. Therefore, the data set is nothing more than several years' matrices.

We construct the credit rating transition matrices using internal data (Table 1). The numbers of customers who went through credit rating migration are summed across categories.

$$\text{Probability of transition from rating } m \text{ to } n = \frac{\text{Number of customers whose ratings migrated from } m \text{ to } n}{\text{Number of customers with rating } m.}$$

3.2. Correlation

"Correlation" is defined as a data set to incorporate the correlation between industries in the simulation. It is a matrix of correlations between industry scores obtained from the internal data. The industry score is the average score of the customers in each industry. Incorporation of credit rating transition correlation into the simulation enables us to quantify the credit risk in consideration of chain default

Table 1
EXAMPLE: TRANSITION MATRIX

	Year $n+1$													
Year n	1	2	3	4a	4b	4c	5a	5b	5c	6a	6b	6c	7	D
1	0.81	0.13	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	0.76	0.17	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.03	0.84	0.02	0.03	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
4a	0.00	0.00	0.00	0.69	0.15	0.07	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00
4b	0.00	0.00	0.00	0.25	0.33	0.21	0.10	0.05	0.03	0.02	0.01	0.00	0.01	0.00
4c	0.00	0.00	0.00	0.07	0.19	0.33	0.24	0.09	0.04	0.02	0.01	0.00	0.01	0.00
5a	0.00	0.00	0.00	0.03	0.06	0.19	0.36	0.21	0.08	0.04	0.02	0.01	0.01	0.00
5b	0.00	0.00	0.00	0.01	0.02	0.07	0.21	0.35	0.18	0.07	0.04	0.02	0.02	0.00
5c	0.00	0.00	0.00	0.01	0.01	0.02	0.08	0.22	0.33	0.18	0.08	0.03	0.03	0.01
6a	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.08	0.22	0.35	0.16	0.06	0.06	0.01
6b	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.04	0.09	0.23	0.32	0.16	0.11	0.02
6c	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.11	0.25	0.30	0.22	0.03
7	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.05	0.10	0.17	0.56	0.06
D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

across industries. We assume that each of the nine industries specified in the Industry Classification Table of the Bank of Japan consists of only one company.

To estimate the correlation between industries, we first measure and standardize the average industry score. In this paper, we use the weighted average according to the sales amount. We then measure the correlations between industries with respect to the logarithmic rate of change in industry score.

3.3. Industry Contribution Rate

"Industry contribution rate" is defined as the degree to which each company's fluctuation can be described by the movement factors (independent variables) representing the industry to which each company belongs. Our model focuses on industries as independent variables among others such as country and company group. The contribution rate corresponds to the coefficient of determination in regression analysis in that the square root of the coefficient of determination is equal to the industry contribution rate.

In this model, several industries are independent variables. The ratio of each independent variable's impact is its industry ratio. The square of the variable's multiple coefficient of correlation is its industry contribution rate.

We estimate the industry contribution rate as the correlation coefficient by using regression analysis on the relative movement of scores for individual companies against industry scores (calculated in Section 2.2). We assume in our model that the movement of the scores for individual companies can be described by one industry only. (See the simple regression model below.)

$$X_{j,y} = \alpha_j + \beta j M_{i,y} + \varepsilon_j ,$$

where $x_{j,y}$ denotes the score of company j for year y; α and β denote the regression coefficient; $m_{i,y}$ denotes the average score of industry i for year y; and ε_j denotes the error term.

Because it is difficult to apply individually the industry contribution rate measured for each company (because of data reliability questions and operational limitations), we use one identical industry contribution rate for one industry. We calculate the industry contribution rate to be uniformly applied to one industry by averaging the industry contribution rates of the companies with scores that are positively correlated with those of the relevant industry.

Here, however, the average of the industry contribution rates calculated for each industry is uniformly applied to all customers. The average of the industry contribution rates with positive correlation is 0.5.

3.4. Correlation between Individual Companies

The correlation between individual companies is calculated on the basis of the above analysis. The correlation between company 1 in industry i and company 2 in industry j is given as: $\rho_{12} = C_{ij} \cdot r_1 \cdot r_2$, where C_{ij} denotes the correlation between industry i and industry j, r_1 denotes the industry contribution rate of company 1, and r_2 denotes the industry contribution rate of company 2.

Because both r_1 and r_2 are 0.5, $r_1 \cdot r_2 = 0.25$. That is, the correlation between companies in the same industry is 0.25. The maximum correlation between companies in different industries is 0.25 (distributed between 0.1 and 0.2).

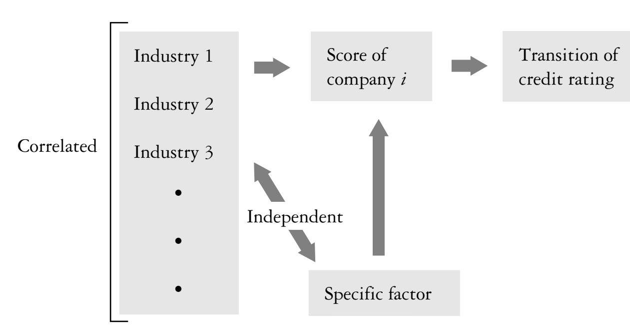
4. Monte Carlo Simulation

4.1. Credit Rating Transition Scenario

Two factors are incorporated into the credit rating transition model, that is, the specific factor for each company and the correlation between industries (Figure 2). In our model, we assume no distribution of profit and loss attributable to credit risk. The default scenarios in the future are generated by moving the following two factors

Figure 2

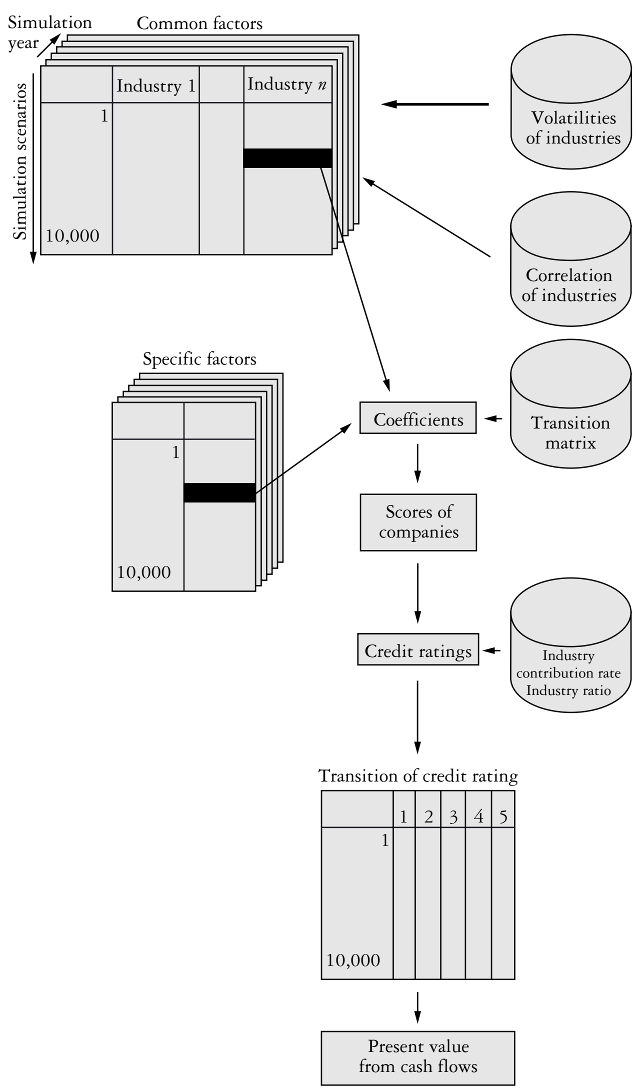
Credit Rating Transition Model



through Monte Carlo simulation: movement of credit rating transition probabilities, including default, and uncertainty of credit rating transition of each customer, including default, under a given credit rating transition probability (Figure 3).

As for movement of credit rating transition probabilities, calculating the standard deviation of credit rating transition probabilities—based on the data for a five-year period only—may not be adequate in light of data reliability. In our model, we generate the simulation of movement of credit rating transition probabilities using the bootstrap method as follows.

Figure 3
FLOWCHART OF MONTE CARLO SIMULATION



The matrices for each year in the future to be used in simulation are selected at random from given sets of matrices by creating random numbers. Although it is possible to put discretionary weight on selection, the same probability is applied in our model. We use selected matrices as the transition probability in the future.

Regarding uncertainty of credit rating transition (credit rating transition scenario), the credit rating is moved annually. The credit rating transition variable V_i is defined for each customer. V_i follows normal distribution. Mean μ and standard deviation σ can take discretionary numbers. Credit rating is moved as follows.

We determined the credit rating transition matrix used in the simulation for each year after incorporating the correlation (described later). Z_{mn}, defined as follows, is determined with a given credit rating transition matrix $[P_{m \to n}]$, according to the credit rating transition.

$$
\begin{aligned}
P_{m \to 1} &= 1 - F(Z_{m1}) \\
P_{m \to 2} &= F(Z_{m1}) - F(Z_{m2}) \\
&\vdots \\
P_{m \to 7} &= F(Z_{m6}) - F(Z_{m7}) \\
P_{m \to d} &= F(Z_{m7}),
\end{aligned}
$$

where $P_{m \to n}$ denotes the rate of transition from rating m to n, and F denotes the cumulative distribution function of $N(\mu, \sigma^2)$.

The credit rating of customer i, whose current rating is l, will be m after one year, which is the largest number that satisfies $Z_{lm} < V_i$, where the credit rating transition variable V_i for customer i is created at random.

Credit rating transition variable V_i, in consideration of correlation, is created to incorporate the correlation into the customer's credit rating transition. We use the following regression model on the assumption that each company's movement can be explained by the industry movement.

$$V_i = a_i + b_{1i}X_1 + b_{2i}X_2 + \ldots + \varepsilon_i,$$

where X_j denotes the driving factor common to industry j—multivariate normal distribution, b_{ji} denotes the sensitivity of company i to the driving factor of industry j, and ε_i denotes the movement specific to company i.

Coefficients are determined by the industry contribution rate and the industry ratio, defined respectively, as follows:

Industry contribution rate : $\sqrt{\dfrac{Var\left(\sum_j b_{ji}X_j\right)}{Var(V_i)}}$

Industry ratio: $b_{1i} : b_{2i} : \ldots$

The mean and standard deviation of V_i can take discretionary numbers. For the sake of simplicity, we adjust the coefficients in the following analysis so that V_i will follow standard normal distribution. Here, we move the rating on the condition that one industry consists of one company.

V_i : Credit rating transition variable $\sim$N(0,1) for company i is defined as $V_i = r_i X_{G(i)} + \sqrt{1 - r_i^2}\varepsilon_j$

i : Company

$G(i)$: Industry of company i

$X_{G(i)}$: Variable ~ N(0,1) common to the industry of company i

ε_i : Variable ~ N(0,1) specific to company i

r_i : Industry contribution rate of company i to industry $G(i)$

$\rho_{\varepsilon_i \varepsilon_i} = \begin{cases} 0\ (I \neq J) \\ 1 (I = J) \end{cases}$ (The correlation between different company variables is 0)

$\rho_{\varepsilon_i X_{G(j)}} = 0$ (The correlation between company variable and industry variable is 0)

$\rho_{X_{G(i)} X_{G(j)}}$: Coefficient of correlation between industries $G(i)$ and $G(j)$ (given correlation matrix)

$\rho_{V_i V_j} = r_i \cdot r_j \cdot \rho_{X_{G(i)} X_{G(j)}}$

Random number X_m is created by function of multivariate normal distribution $\sim$N(0,C).

4.2. Result of Calculation

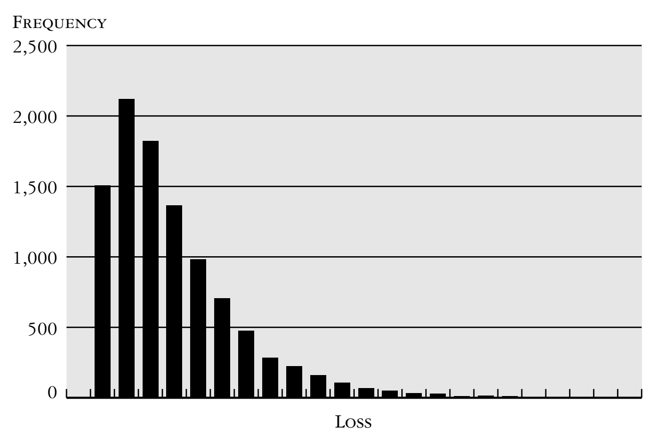
Table 2 compares the amounts of required capital, which are identical to the maximum loss (see Section 6.1), based on the regulations of the Bank for International Settlements (BIS) and the qualification of credit risk with respect to our loan portfolio in a certain category at a certain time.

The required capital calculated by using the quantification of credit risk, which considers obligors' creditworthiness, is more effective than that based on a uniform formula without such consideration. The correlation between individual companies has been incorporated into the credit rating transition of each company in the Monte Carlo simulation. This incorporation enables us to perform the simulation assuming chain default and to generate distributions skewed sufficiently toward the loss side. This incorporation also enables us to manage functions such as concentration risk or the risk of concentration of credit in, for example, a particular industry (Figure 4).

Table 2
Comparison of Required Capital

	Required Capital (Millions of Yen)	Ratio to the Risk Asset (Percent)
Risk asset	17,326,350	—
Required capital, based on BIS regulations	1,386,108	8.00
Required capital, based on the quantification of credit risk	693,889	4.00

Figure 4
Distribution of Losses



5. Credit Risk Delta

5.1. Credit Risk Delta

Japanese city banks have tens of thousands of clients whose creditworthiness ranges from triple A to unrated (for example, privately owned businesses). Monte Carlo simulation is therefore inappropriate for each new lending transaction since the simulation demands a heavy calculation load and accordingly a lengthy credit approval process. In our model, we perform Monte Carlo simulation once for all the portfolios and then calculate the risk ratio on the uncovered balance of each loan on the basis of the simulation result. We have devised a method to calculate the risk amount in a particular category by summing individual risks. We introduce the concept of credit risk delta to achieve this purpose. The credit risk delta is a measurement of the marginal increase in the risk of the entire portfolio when loans to one segment that constitutes the portfolio are increased. The maximum credit risk delta is measured at a 99 percent confidence interval. The average of credit risk deltas is equal to the expected loss, but the delta's maximum does not correspond to the maximum loss.

$$\text{Credit risk delta by segment} = \frac{\text{the credit risk after 10 percent increase in loans to a segment} - \text{the present credit risk}}{\text{10 percent of the loans to the segment.}}$$

Our model uses a 13-x-2 segmentation based on credit rating (thirteen grades) and loan period (one year or less, over one year). Two cases are considered for each segment (that is, a new loan and an increase in an existing loan). Accordingly, credit risk deltas are measured in 13-x-2-x-2 patterns.

5.2. Method of Measuring the Credit Risk Delta: Part 1

We consider two patterns of increase in loan amount:

- To increase the amount of an existing loan. This is the case where the balance of the existing loans in the relevant segment is increased at a certain ratio.
- To add a new loan client. This is the case where a new loan client is added to the relevant segment on the assumption that the attributes of the new loan are essentially the same as those of existing loans.

In light of actual banking practice, both of the above are extreme cases. Reality is expected to lie in the middle. Accordingly, we determine that the credit risk delta is the average of the results in the two cases. Methods of measurement differ depending on the patterns mentioned above.

Increase in the Amount of an Existing Loan

The profit and loss attributed to each customer are proportionate to the principal amount of the loan. With respect to a client whose loan is increased at a certain ratio, therefore, the same coefficient should be applied to the profit and loss. The increment is the credit risk delta. It is not necessary to run a new Monte Carlo simulation.

New Loan Client

The default of a new loan client is not perfectly linked to that of an existing loan. Therefore, it is necessary to run a new Monte Carlo simulation. In our model, the Monte Carlo simulation (generation of default scenarios) is performed separately for the entire loan portfolio, including new loan clients selected at random in a certain proportion from existing loan clients in the relevant segment. New loan clients are deemed to be new on the assumption that new loan attributes are essentially the same as those of existing loans. The credit risk delta is the increment of the loss attributable to the addition of new loan clients.

This method makes it difficult to obtain the credit risk delta at a desired confidence interval because of the characteristics of the simulation. (The confidence interval for the measurement of credit risk delta under a certain scenario may not always correspond to that for the entire portfolio, which is 99 percent, for example.)

5.3. Method of Measuring the Credit Risk Delta: Part 2

Although it is possible to calculate credit risk delta only using the method described in Section 5.2, the order of the risk ratios measured therein, as mentioned above, may not always correspond to the credit ratings, hence an unrealistic outcome. In our model, we determine the credit risk delta on the basis of the analysis of its distribution, as described below.

Figure 5 presents the distribution of loss amounts for the entire portfolio. Figure 6 is an example of the credit risk delta measurement for each segment in the case of an increase in the amount of existing loans in the segment that covers rating 6a and periods longer than one year. We determined that the credit risk delta is the increment of the risk amount when the loan balance in such a segment is increased by 10 percent.

Figures 5 and 6 show that the credit risk delta increases monotonically with the width of the confidence interval for maximum loss. Therefore, the credit risk delta corresponds to the confidence interval for the maximum loss (the method described in Section 5.2). On the other hand, the credit risk delta fluctuates significantly at each particular point. Accordingly, the risk amount based simply on the credit risk delta at the relevant confidence interval may move a great extent when the confidence interval is slightly shifted. Consequently, the distribution of the observed credit risk deltas should be statistically analyzed to find out the relationship between credit risk delta and the confidence interval as follows.

First, the credit risk delta ratio is equal to the credit risk delta (measured above) divided by the increment of loan balance (loan balance JPY95,400 million × 10 percent). The ratio is depicted in Figure 7. To improve the visual observation, the vertical axis represents the fourth root of the credit risk delta ratio.

Figure 8 plots the fourth root of credit risk delta ratio on the vertical axis with the horizontal axis representing the standard normal variables (Q-Q plotting), which replace the confidence intervals in Figure 7. Figure 8 shows that the credit risk delta in Q-Q plotting is distributed almost linearly. That is, the fourth root of credit risk delta follows approximately normal distribution.

Then, we estimate the regression coefficient by performing regression analysis on this Q-Q plotting. Since the distribution can be approximated by a linear graph, we estimate the relationship between confidence interval and credit risk delta ratio through the linear regression function in this analysis.

Credit risk delta V is given as $v = (a + bx)^4$, where x denotes the standard normal variable corresponding to the confidence interval in the standard normal distribution (2.33 for 99 percent).

The regression analysis for the example presented in Figure 8 gives the following result: a=0.437, b=0.0867

Figure 5

Distribution of the Portfolio's Losses

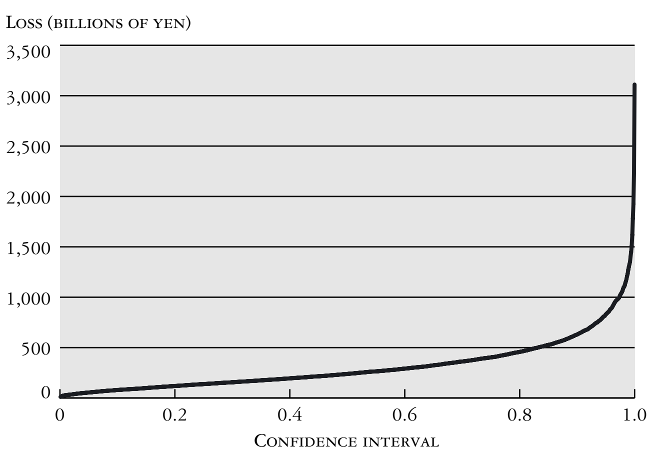


Figure 6

Credit Risk Delta Measurement: An Example

Marginal Risk (Rating 6a and Periods Longer Than One Year)

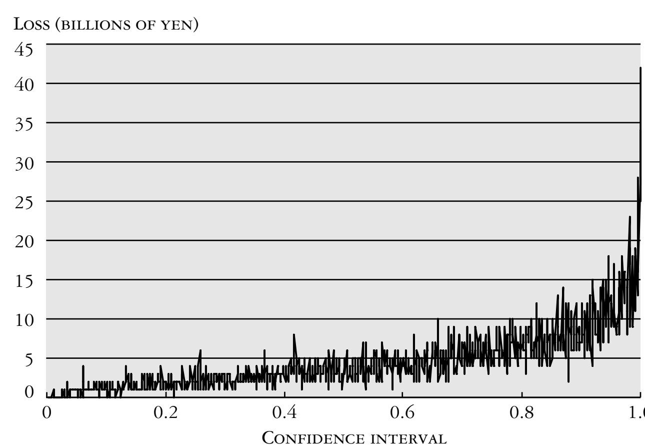


Figure 7

CREDIT RISK DELTA RATIO
Fourth Root of Credit Risk Delta (Rating 6a and Periods Longer Than One Year)

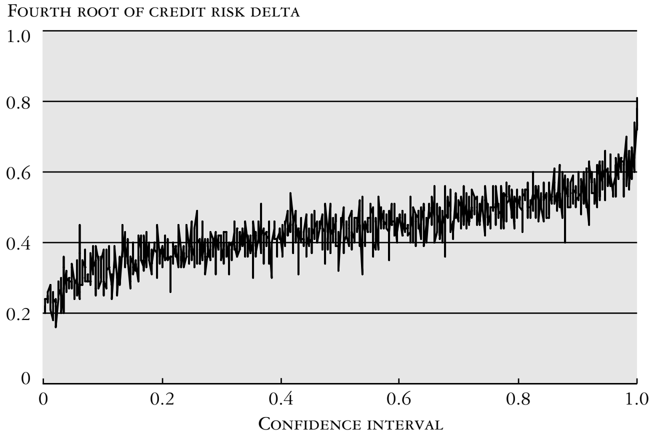
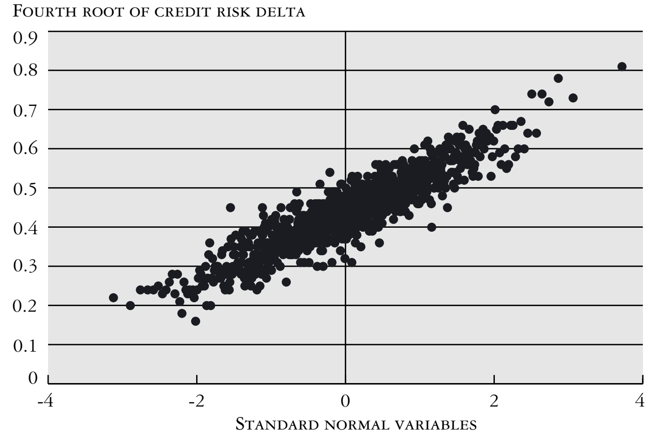


Figure 8

CREDIT RISK DELTA RATIO MEASURED IN Q–Q PLOTTING
(Rating 6a and Periods Longer Than One Year)



(coefficient of determination $R^2 = 0.83$, number of samples = $10,000$). That is, the credit risk delta ratio of the existing loans in the segment that covers rating 6a and periods longer than one year is estimated at $(0.437 + 0.0867 \times 2.33)^4 = 0.167$ (16.7 percent).

5.4. COMPILATION OF THE RESULTS AND ADJUSTMENT OF THE CREDIT RISK DELTAS

We now classify in thirteen ratings the rates measured for 13-x-2-x-2 categories. For each rating, we calculate the average of the rates for the periods of one year or less and more than one year (weighted average according to outstanding balance) as well as the average of those for new loan clients and existing loans (arithmetic mean).

Credit risk delta is regarded as the degree of effect that an individual risk has on the portfolio. In our model, we made an adjustment to equate the sum of the credit risk deltas with the risk of the entire portfolio so that risks ranging from those of an individual company to those of the whole portfolio can be interpreted consistently through credit risk delta (Table 3). The sum for all the clients is Σ.

When Σ Credit Risk Delta < the Risk Amount for the Entire Portfolio

We adjust the credit risk deltas by multiplying them with a constant—risk amount for the entire portfolio/Σ marginal risk—so that their sum will equal the risk amount for the entire portfolio.

When Σ Credit Risk Delta > the Risk Amount for the Entire Portfolio

We do not adjust the credit risk deltas. We regard Σ credit risk delta as the risk amount for the entire portfolio. Furthermore, the capital required for credit risk is assumed to be equal to credit risk.

6. BUSINESS MANAGEMENT BASED ON THE QUANTIFICATION OF RISK

6.1. ALLOCATION OF CAPITAL

The amount of capital required to cover each type of risk can be quantified based on the concept of maximum loss, a measurement common to all risks. We assign capital to each risk as "allocated capital." Required capital equals the

Table 3
RESULT OF CREDIT RISK DELTA CALCULATION

Rating	Credit Cost (Percent)	Credit Risk (Percent)	Asset (Millions of Yen)	Uncovered Balance (Millions of Yen)	Required Capital (Millions of Yen)	Percent-to-Asset Ratio	BIS Regulation (Percent)
1	0.00	0.00	1,194,230	1,185,094	0	0.00	8.00
2	0.00	0.00	876,139	846,015	0	0.00	8.00
3	0.00	0.03	1,712,623	1,555,640	467	0.03	8.00
4a	0.05	1.38	725,792	488,218	6,737	0.93	8.00
4b	0.07	2.07	865,106	546,752	11,318	1.31	8.00
4c	0.12	2.79	1,221,975	744,359	20,768	1.70	8.00
5a	0.20	4.05	1,744,059	1,068,275	43,265	2.48	8.00
5b	0.31	5.87	1,951,575	1,131,679	66,430	3.40	8.00
5c	0.71	9.18	1,788,003	952,833	87,470	4.89	8.00
6a	1.05	12.21	1,824,986	1,034,857	126,356	6.92	8.00
6b	1.54	15.33	1,330,100	670,638	102,809	7.73	8.00
6c	1.88	16.66	912,579	477,417	79,538	8.72	8.00
7	3.37	21.10	1,179,183	704,891	148,732	12.61	8.00
TOTAL			17,326,350	11,406,668	693,889	4.00	8.00

risk amount measured as maximum loss and is kept below the allocated capital amount. This enables us to keep the risk amount within the capital and to perform safe and sound bank management. Table 4 gives an example.

6.2. INTEGRATION OF PROFITABILITY MEASUREMENT

We measure the profitability of each business area using risk-adjusted return on allocated capital (integrated ROE), not return on asset (ROA). We calculate the integrated ROE as follows:

Integrated ROE =
(net business profit − expected loss)/allocated capital.

The ratio of profit net of expected loss to the risk actually taken is termed "risk-return ratio."

Risk-return ratio =
(net business profit − expected loss)/capital required to cover risk.

The risk-return ratio is useful when assessing the profitability of each business area or reviewing the capital allocation because it (more than others) provides tools for decision making on the input of more capital and resources in the more profitable existing business lines.

We use the allocated capital utilization ratio to measure the rate of usage of the allocated capital.

Allocated capital utilization ratio =
capital required to cover risk/allocated capital.

With these indices, we can consistently measure the profitability of the bank as a whole, each business area, each branch, and each customer.

6.3. EVALUATION OF PERFORMANCE

Evaluation of profitability by customers using integrated ROE in the example in Table 5 is as follows: Although Customer B yields a better interest rate spread (or interest rate spread minus credit cost) than Customer A, its profitability—in light of credit risk—is lower than that of A.

Table 4
ALLOCATION OF CAPITAL: AN EXAMPLE
Billions of Yen

	Required Capital Based on BIS Regulations	Required Capital Based on the Quantification	Allocated Capital
Risk asset 41,042	41,042 x 8% = 3,283	Credit risk 1,465	1,538
		Interest rate risk [ALM] 87	712
		Equity risk 543	570
Market risk in trading 316	25	Market risk 25	416
41,358	3,308	2,120	3,236

Table 5
PROFITABILITY BY CUSTOMER

Customer	Credit Rating	Loan Amount (Millions of Yen)	Profit (Millions of Yen)	Credit Cost (Millions of Yen)	Credit Risk (Millions of Yen)	Integrated ROE (Percent)
A	5b	1,000	10	3.10	58.70	11.75
			(1.00%)	(0.31%)	(5.87%)	
B	5c	1,000	15	7.10	91.80	8.61
			(1.50%)	(0.71%)	(9.18%)	

Notes: Recovery rate is zero. Percentages in parentheses show annual rate on loan amount.

Table 6
PERFORMANCE EVALUATION

	Comparison between the Previous Month and This Month				
Grade	Integrated ROE	Risk-Return Ratio	Allocated Capital Utilization Ratio	Evaluation	
A	Up	Up	Up	Very good	Capital utilization ratio increased. Profitability improved.
B	Up	Up	Down	Good	Although profitability was improved, capital utilization ratio declined. Potential remains.
C	Up	Down	Up	Good/fair	Although both capital utilization ratio and profitability were improved, the profitability of new business was low.
D	Down	Up	Down	Good/fair	Both capital utilization ratio and profitability declined. Return on risk improved.
E	Down	Down	Up	Poor	Although capital utilization ratio increased, it did not lead to improved profitability.
F	Down	Down	Down	Poor	Capital utilization ratio declined. Profit decreased as well.
			More than 100%	Warning	Risk (capital required to cover risk) exceeds the allocated capital. Need for reduction.

The integrated ROE, risk-return ratio, and allocated capital utilization ratio employed together enable us to evaluate the performance of each branch. Table 6 shows the possible combinations of the three indices and the corresponding evaluations.

7. CONCLUSION

Safe and sound banking is maintained through the allocation and control of capital by the use of integrated risk management techniques that are based on quantification of the risks inherent in the banking business. Furthermore, business management with the integrated ROE (that is, risk-adjusted ROE) facilitates efficient utilization of capital. Such management contributes to the growth of a bank's profitability. By promoting this type of management at Japanese banks with large portfolios of transactions—both in number and amount—the concept of credit risk delta is an effective method. The credit risk delta helps to quantify risks while taking into account the types of business management city banks use. This management method provides consistent and simple measurement applicable to all the levels—from individual customers up to branches and the bank as a whole.

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ENDNOTE

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Commentary

William Perraudin

I shall divide my comments into three parts: (i) general thoughts about credit risk modeling and the technical difficulties involved, (ii) remarks on the implementation of such models, with particular reference to the papers in this session by Wilson and by Nishiguchi et al., and (iii) a discussion of the policy implications of credit risk modeling and the light shed on this issue by the papers by Jones and Mingo and by Gray.

Background

It is important to understand the background to the current interest in credit risk modeling. Recent developments should be seen as the consequence of three factors. First, banks are becoming increasingly quantitative in their treatment of credit risk. Second, new markets are emerging in credit derivatives, and the marketability of existing loans is increasing through growth in securitizations and the loan sales market. Third, regulators are concerned about improving the current system of bank capital requirements, especially as it relates to credit risk.

These three factors are strongly self-reinforcing. The more quantitative approach taken by banks could be seen as the application of risk management and financial engineering techniques initially developed in the fixed income trading area of banks' operations. However, they raise the possibility of pricing and hedging credit risk more generally and encourage the emergence of new instruments such as credit derivatives. Furthermore, if banks are adopting a more quantitative approach, regulators may be able to develop more sophisticated and potentially less distortionary capital requirements for banking book exposures. However, if regulators do permit the use of models in capital requirement calculations, banks will have a substantial incentive to invest further in the development of credit risk models.

The basic problems in developing models of credit risk are (i) obtaining adequate data and (ii) devising a satisfactory way of handling the covariability of credit exposures. On data, banks face the difficulty that they have only recently begun to collect relevant information in a systematic manner. Many do not even know simple facts about defaults in their loan books going back in time. Although serious, this difficulty is transitional and will be mitigated as time goes by and perhaps as banks make arrangements to share what data exist.

The more serious data problem is that bank loans and even many corporate bonds are either partly or totally illiquid and mark-to-market values are therefore not

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available. This means that one must rely on some other measure of value in order to establish and track the riskiness of credit-sensitive exposures. Two approaches have been followed by credit risk modelers. J.P. Morgan and Credit Suisse Financial Products in their respective modeling methodologies, CreditMetrics and CreditRisk$^+$, employ ratings and probabilities of ratings transitions as bases for measuring value and risk. The consulting firm KMV uses equity price information to infer a borrower's underlying asset value and the probability that it will fall below some default trigger level.

The second major problem faced by credit risk analysts is that of modeling the covariation in credit risks across different exposures. It is particularly difficult to do this in a tractable way while respecting the basic nature of credit risk, that is, return distributions that are fat-tailed and highly skewed to the left. Two approaches have been taken. On the one hand, the CreditMetrics approach to covariation consists of supposing that ratings transitions are driven by changes in underlying, continuous stochastic processes. Correlations between these processes (and hence in ratings transitions) are inferred from correlations in equity returns (to some degree therefore relying on the KMV methodology). CreditRisk$^+$, on the other hand, allows parameters of the univariate distributions of individual exposures to depend on common conditioning variables (for example, the stage of the economic cycle). Conditionally, exposures are supposed to be independent, but unconditionally they are correlated.

Implementations of Credit Risk Modeling

Two papers in this session represent implementations of credit risk methods, namely, those by Wilson and by Nishiguchi et al. The Wilson study describes an approach to credit risk modeling that resembles CreditRisk$^+$. More specifically, this approach employs binomial and multinomial models of default/no-default events and of movements between ratings. Correlations between the risks on different exposures are incorporated by allowing the probabilities to vary according to whether the macroeconomy is in one of two states. It is slightly difficult to see how such a framework would perform in actual applications. For example, it might be thought of as a problem that the economy can only be in a boom or a bust. Integrating over a larger number of states or over some continuous set of different states might be more natural.

Although the Wilson paper does discuss ratings changes, the primary focus (as in CreditRisk$^+$) is on probabilities of default. Credit losses are deemed to occur only if a borrower defaults and not if, for example, its rating declines sharply without default taking place. This approach resembles traditional practices in insurance and banking markets. By contrast, CreditMetrics takes a more portfolio-theoretic approach in which losses are registered as the credit rating of a borrower declines. From an economic viewpoint, the portfolio-theoretic approach appears preferable. For example, it more straightforwardly yields prescriptions about how a given credit risk may be hedged.

The Nishiguchi et al. paper resembles CreditMetrics in that it takes a more portfolio-theoretic approach. However, in its treatment of correlations, its approach, like that of Wilson and CreditRisk$^+$, is to allow exogenous conditioning variables to serve as the source of covariation in credit risk. Like the Wilson paper, the Nishiguchi et al. paper does not explore the effectiveness of the authors' very complicated approach to modeling correlation. Since correlations are crucial inputs to the credit risk measures that come out of such models, a critical evaluation of the sensitivity of the results to different approaches would be desirable.

Policy Relevance

The other two papers in this session, those by Jones and Mingo and by Gray, provide extremely useful snapshots of what U.S. and Australian banks, respectively, have achieved in their implementation of quantitative credit risk modeling. In both cases, it is notable quite how far the banks have gotten, although significant obstacles remain. Substantial efforts have been directed at collecting data and implementing credit risk measurement systems. Almost no banks follow a fully portfolio-theoretic approach. Most employ ratings-based approaches like CreditMetrics or CreditRisk+ rather than KMV techniques. Supervisors in both the United States and Australia have had extensive contact with banks, monitoring progress and, in the Australian case, coordinating the exchange of data.

For regulators, a crucial question that Jones and Mingo, and to some extent Gray, address is whether bank models are sufficiently developed and comprehensive to be employed in the calculation of risk-sensitive capital requirements on banking book exposures. Both studies are quick to conclude that global use of credit risk models for the entire banking book is quite infeasible at the current stage of development of credit risk modeling. Nevertheless, both studies view the adoption of such models in some form as inevitable. The primary argument advanced by Jones and Mingo is that large U.S. banks currently engage in substantial "capital arbitrage," using securitizations and other transactions to cut their capital levels while retaining the underlying credit risk. A more positive argument, perhaps, is that by allowing the use of models, supervisors may reduce distortions in banks' portfolio choices attributable to the current capital requirement system, with its unsophisticated approach to risk weighting.

There are two ways in which credit risk models could be employed in a limited sense for capital requirement calculations. The first would involve their use as a guide in banking supervision. In their contact with banks, U.S. supervisors suggest capital add-ons for banking book assets over and above the Basle 8 percent capital charge. In the United Kingdom, such add-ons have a more formal status in that regulators actually require banks to hold amounts of capital over and above the Basle 8 percent charge. Thus, U.K. banks are required to maintain risk-asset ratios for each U.K. bank (that is, the ratio of broad capital to risk-weighted assets) that exceed bank-specific trigger ratios. In principle at least, output from credit risk models could be used as an input to decisions about such formal or informal capital add-ons.

Second, credit risk models could be employed for part but not all of the banking book. Jones and Mingo have a limited discussion of this point. The section of the banking book to which models might be applied could be selected either because it is the source of substantial capital arbitrage or possibly because the assets involved have stable credit risk on which considerable information is available. Jones and Mingo presumably have the first of these two criteria in mind when they argue that certain transactions involving securitization should be subjected to modeling. More generally, loans issued by borrowers that already possess ratings on traded debt or that have quoted equity might be obvious candidates for credit risk modeling. Alternatively, some particularly homogeneous asset categories such as mortgages, personal loans, or credit card debt may be judged to have stable default behavior susceptible to credit risk modeling.

Conclusion

The papers in the session serve to underline the fact that credit risk modeling will be a crucial area for regulators and industry practitioners in coming years. It is hard to resist the conclusion that models in some shape or form will be used before too long in bank capital calculations. As Jones and Mingo argue, the current division of bank assets between the trading and banking books in and of itself obliges regulators to consider changes since it provides banks with strong incentives to reduce capital requirements through arbitrage. On a more positive note, making bank capital requirements more sensitive to the credit risks a bank faces will reduce distortions inherent in a nonrisk-adjusted system without impairing the main function of capital requirements, that of bolstering the stability of the financial system.

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Distinguished Address

Supervisory Capital Standards: Modernise or Redesign?

by Edgar Meister

Supervisory Capital Standards: Modernise or Redesign?

Edgar Meister

I. I am delighted to have the opportunity to speak to such an eminent group at this important conference on capital regulation.

"If you see a banker jump out of the window, jump after him: there is sure to be profit in it," said the eighteenth-century French philosopher Voltaire. Looking at the situation in Southeast Asia, I am not entirely convinced that it would always be wise to follow Voltaire's advice. Even if all banks pursue the same course, their actions are not necessarily appropriate.

It is also becoming clear, however, that the Asian crisis has given new urgency to the already important topics of risk and capital adequacy. In that respect, this conference has come at a very opportune moment.

The question addressed by this conference is whether the prudential supervisory standard established by the 1988 Basle Capital Accord can meet the challenges of the twenty-first century. If an entirely new standard is needed, then our task is to consider which alternative system of capital requirements might be superior to the present one. There are differences of opinion on these issues, not only between the supervised institutions and the supervisors but also, in some cases, among the supervisors themselves.

In debating whether it is better to modernise the Basle Accord or to redesign it by developing a new set of capital rules, we need to keep two considerations in mind:

- A capital standard should promote the security of individual institutions—that is, each institution's ability to manage risk and to maintain an adequate cushion of capital against losses—and the overall stability of the banking system. I assume that no one wants less financial market stability than we have now.
- The easing of regulatory burdens and the creation of a level playing field for banks are important objectives. Although the extent of the regulatory burdens imposed by different capital standards should not be the main criterion in deciding whether to modernise or redesign the Basle Accord, efforts to streamline regulation are welcome because they reduce the competitive disadvantages experienced by banks and optimise the cost-effectiveness of the supervisory system. A related consideration is that any prudential measures taken should not create competitive discrepancies between different groups of banks.

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II. In terms of risk considerations, an ideal capital standard would fully capture an institution's risks and would produce a capital base that takes due account of risk. An ideal standard would also increase market discipline. In reality, we are still far away from these theoretical ideals. There are differences in the measurability and hence also in the controllability of the main risks to which banks and other financial intermediaries are exposed. Market risks, for example, can be measured quite accurately using existing data and risk-monitoring techniques.

By contrast, in what is still the main risk area for banks, credit risk, a purely quantitative determination of risk—comparable to market risk modeling—is much more difficult and has not yet been achieved. For that reason, assessment of credit risk still relies heavily on traditional methods—that is, the judgement of the banks' credit officers.

Efforts to improve the quantification of credit risk through the use of models are mainly hampered by insufficient or poor-quality data. For that reason, the survey of data sources for credit risk models that was recently released by the International Swaps and Derivatives Association (ISDA) is very welcome. It remains to be seen, however, whether the quality of the data in major market segments will be adequate.

Data problems also complicate the modeling of operational risks. These risks range from the inadequate segregation of duties to fraud and errors in data processing. At present, measures of these risks are "guesstimates" based largely on data not objectively observable.

III. The difficulties in risk measurement are a problem not only for institutions, but also for the supervisory agencies that define capital requirements. Our existing regulatory framework aims to ensure that institutions have an adequate cushion of capital as a protection against unavoidable losses. Although this "shield" of capital is supposed to cover all risk factors—including operational and legal risks—the calculation of required capital has essentially been geared to a single risk factor: default risk. At the beginning of this year, separate capital requirements were implemented for banks' market risk exposures, but default risk remains the primary target of capital rules.

Bankers and some supervisors have recently called the Capital Accord into question, not least because of its inexact categorisation of risks. They point out, for example, that exposures to countries in the Organization for Economic Cooperation and Development are assigned a uniform risk weight of 0 percent, although there are considerable differences in risk within that group of countries. Similar questions arise about the assignment of a 100 percent risk weight to exposures to nonbanks, a group that includes blue-chip firms known worldwide. Additionally, critics claim that risk weights under the Basle Accord do not take into account the degree of diversification in individual institution's loan books—an oversight that may prevent institutions from using their funds in the most productive way.

IV. This is the backdrop against which more sophisticated methods of credit risk measurement are being discussed. These methods include a subtly differentiated prudential weighting scheme, the use of internal ratings, the inclusion of portfolio effects and credit risk models, and certain new concepts completely different from the Capital Accord. It is my assessment that supervisors are fundamentally open-minded about these alternatives. Notable among the new concepts are the precommitment approach put forward by economists from the Board of Governors of the Federal Reserve System and a framework that emphasises self-regulation, proposed by the Group of Thirty (G-30).

Under the precommitment approach, a bank itself decides how much capital it will hold within a given period to cover the risks arising from its trading book. Sanctions will apply if the accumulated losses exceed that amount. This approach is appealing in many respects. It could ease the job of supervisors and reduce the regulatory burden for institutions. Moreover, the approach is highly market-oriented.

The precommitment approach poses a number of fundamental difficulties, however. First, it involves a purely ex post analysis of a bank's risk and capital status.

This perspective means that supervisory authorities are reacting to market outcomes and to choices already made by an institution rather than specifying a given level of capital for the institution in a preventive manner. Without wishing to preempt this afternoon's discussion, I would argue that some institutions facing regulatory sanctions for failing to commit sufficient capital to cover their losses might be motivated to accept additional risk—on the theory that "If you are in trouble, double."

A second problem with the precommitment approach is the difficulty of finding a logically consistent penalising mechanism. If an institution takes risks that result in losses greater than the capital reserved, banking supervisors would have to impose mandatory fines or higher capital requirements, which would end up exacerbating the financial difficulties of that institution.

Another penalty contemplated under the precommitment scheme—public disclosure—points to a third problem with this approach. The idea that an institution could be required to inform the market if it failed to limit its losses has met with considerable reservations on the part of many institutions and supervisory authorities. I am quite doubtful whether institutions would be prepared to go that far in terms of disclosure. At the risk of exaggeration, I would suggest that the precommitment approach represents a bank's promise that it will not become insolvent. If that promise cannot be kept, then the question whether supervisors can or will impose sanctions remains open—at least in critical cases.

A proposal by the G-30, which goes further than the precommitment approach in reducing the role of bank supervisors, essentially leaves the development of regulatory strategies to the market or to a small group of major international financial institutions. The involvement of supervised institutions in the creation of regulatory standards is not new in principle; it has been tried and tested. Whenever industry methods of measuring and monitoring risk have become state of the art, supervisors have been ready to adopt them—as was recently the case with the recognition of internal models for market risk. Nevertheless, in the absence of administrative sanctions to enforce standards, how binding could those standards be?

Trusting solely in effective market controls presupposes a comparatively high degree of transparency. As in the case of the precommitment approach, it is questionable whether all market players would be prepared to disclose their risk positions and losses to the market. Such disclosures would require institutions to reveal market expectations, trading strategies, and other business secrets.

Furthermore, under the G-30 proposal, the interests of the select group of member institutions might not prove to be identical with the general interests of the financial industry. In particular, competitive distortions at the expense of smaller institutions might arise. As mentioned above, an outcome in which supervisory standards cause new competitive problems should at all events be avoided.

V. As concepts, the precommitment approach and the G-30 proposal for self-regulation supply important and thought-provoking ideas. Because of their pronounced market orientation, these alternatives to the present prudential standard would reduce the regulatory burden and give banks greater freedom in their risk management.

At the same time—in addition to the reservations already mentioned—I perceive the danger of a decline in the overall security level of the individual credit institution and the banking system. Existing risks might be covered by less capital than under the Capital Accord.

Although self-regulation aimed at greater market discipline would be welcome, the precommitment approach and G-30 proposal would probably not be able to achieve it on a lasting basis—especially if a bank or a banking system were in a difficult situation. In such a situation, these alternative approaches would not be able to make up for the disadvantages of allowing institutions to maintain a lower capital base.

What should also be given consideration is that both approaches are intended to apply mainly to large banks that operate internationally. These institutions are players with an especially prominent role in maintaining the stability of the financial markets. At the same time, we know that the world of risk has become more complex during the last few years and that the risks borne by institutions under the pressure to perform have increased. Risky high-yield transactions in emerging markets, for example, are likely to become increasingly significant in the future despite the recent turmoil in Asia.

Indeed, the events in Southeast Asia demonstrate how difficult it is to determine bank-specific risks with sufficient accuracy. Even leading rating agencies have tended to run behind the markets in line with the maxim "Please follow me, I am right behind you."

VI. Capital is, therefore, still a modern prudential requirement. The Basle Capital Accord is, in this context, a rough and comparatively simple approach. This standard, which has now been put into practice virtually worldwide, undoubtedly has some weaknesses. It has, however, demonstrated its suitability under changing conditions in the almost ten years since its introduction. In my view, the empirical findings are definitely positive.

The Capital Accord has not worked, however, when the calculated capital was not actually in place. In many countries that have experienced crises, credit institutions had only formally fulfilled the norm of 8 percent minimum capital. An evaluation of actual assets and liabilities in line with market conditions would have shown that the capital had been used up long beforehand.

Because the Capital Accord sets capital requirements more conservatively than do the precommitment approach and the G-30 proposal, there remains a buffer for cushioning the risks that are difficult to measure—operational and legal risks, for instance. To that extent, an adequate cushion of capital can make up for shortcomings in risk identification, measurement, and control.

VII. To come back to the original question: I am in favour of an evolutionary solution. The Basle Accord should be modernised and not—at present—replaced by other concepts. Other approaches are indeed worth discussing, but at present I cannot identify any alternative that would be operationally viable, practicable, and superior to the Capital Accord.

The Capital Accord itself is adaptable enough to allow new developments in the markets to be integrated with its system in a meaningful manner—as occurred in the case of market risk, for example. It can also accommodate all other developments currently under discussion, such as on-balance-sheet netting, credit derivatives, credit risk models, and new capital elements.

The capital requirements established by the Basle Accord will, of course, have to be expanded to include buffers for risks that have so far gone uncovered. For example, given an easing of capital requirements in other areas, buffers for operational risks, valuation risks, and concentration risks must no longer be a "no-go" area.

Generally speaking, further qualitative requirements may also help to curb risks and hence create a stabilising impact in micro- and macro-prudential terms. In that respect, the Basle Committee's "Framework for the Evaluation of Internal Control Systems" is especially important. Qualitative and quantitative minimum standards for the use of credit risk models—validated through extensive testing and application—would also have to be specified in due course.

In my view, self-regulation can have a stimulating effect, but it cannot replace the administrative supervision of banks and other financial intermediaries. To that extent, self-regulation is an approach that complements prudential supervision. I believe that this assessment has been reinforced by various bank crises in the past and borne out yet again by the Asian crisis.

A revised capital framework incorporating greater self-regulation requires that supervisors work closely with financial institutions. Such cooperation should yield regulations that are, on the one hand, up-to-date and compatible with the market and, on the other hand, conducive to market discipline and the stability of the overall system.

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SESSION 3

ISSUES IN VALUE-AT-RISK MODELING AND EVALUATION

Papers by

Jon Danielsson, Casper G. de Vries, and Bjørn N. Jørgensen

Peter F. Christoffersen, Francis X. Diebold, and Til Schuermann

Jose A. Lopez

Commentary by

Beverly Hirtle

The Value of Value at Risk: Statistical, Financial, and Regulatory Considerations

Summary of Presentation

Jon Danielsson, Casper G. de Vries, and Bjørn N. Jørgensen

Value at risk (VaR) has emerged as a major tool for measuring market risk, and it is used internally by banks for risk management and as a regulatory tool for ensuring the soundness of the financial system. A large amount of research work into VaR has emerged, and various aspects of VaR have been extensively documented. There are two areas of VaR-related research that we feel have been relatively neglected: the relationship of VaR to statistical theory and the financial-economic foundations of VaR. Most VaR methods are based on normality, however; as stated by Alan Greenspan (1997), "the biggest problems we now have with the whole evaluation of risk is the fat-tailed problem, which is really creating very large conceptual difficulties."

Common methods for measuring VaR fall into two major categories—parametric modeling of the conditional (usually normal) distribution of returns and nonparametric methods. Parametric modeling methods have been adapted from well-known forecasting technologies to the problem of VaR prediction. As a result, they seek to forecast the entire return distribution, from which only the tails are used for VaR inference.

Value at risk, however, is not about common observations. Value at risk is about extremes. For most parametric methods, the estimation of model parameters is weighted to the center of the distribution and, perversely, a method that is specifically designed to predict common events well is used to predict extremes, which are neglected in the estimation. Nonparametric historical simulation, where current portfolio weights are applied to past observations of the returns on the assets in the portfolio, does not suffer from these deficiencies. However, it suffers from the problem of tail discreteness and from the inability to provide predictions beyond the size of the data window used.

Danielsson and de Vries (1997) apply semi-parametric extreme value theory to the problem of value at risk, where only the tail events are modeled parametrically, while historical simulation is used for common observations. Extreme value theory is especially designed for extremum problems, and hence their semi-parametric method combines the advantages of parametric modeling of tail events and nonparametric modeling of common observations. Danielsson and de Vries (1997) develop estimators for both daily and multiday VaR predictions, and demonstrate that for their sample of U.S.

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stock returns, the conditional parametric methods underestimate VaR and hence extreme risk, which, according to historical simulation, suffers from undesirable statistical properties in the tails. The semiparametric method, however, performs better than either a parametric conditional variance-covariance method or nonparametric historical simulation.

Conditional parametric methods typically depend on the conditional normality for the derivation of multiperiod VaR estimates, primarily because of the self-additivity of the normal distribution. The Basle Accord suggests using the so-called square-root-of-time rule to obtain multiday VaR estimates from one-day VaR values, where multiperiod volatility predictions are obtained by multiplying one-day volatility by the square root of the time horizon. However, relaxation of the normality assumption results in this scaling factor becoming incorrect. Danielsson and de Vries (1997) argue that the appropriate method for scaling up a single-day VaR to a multiday VaR is an alpha-root rule, where alpha is the number of finite-bounded moments, also known as the tail index. This eventually leads to lower multiday VaRs than would be obtained from the normal rule. Hence, the normality assumption may be, counterintuitively, overly conservative in a multiperiod analysis.

Danielsson, Hartmann, and de Vries (1998) examine the impact of these conclusions in light of the current market risk capital requirements and argue that most current methodologies underestimate the VaR, and are therefore ill-suited for market risk capital. Better VaR methods are available, such as the tail-fitting method proposed by Danielsson and de Vries (1997). However, financial institutions may be reluctant to use these methods because current market risk regulations may, perversely, provide incentives for banks to underestimate the VaR.

Danielsson, Jørgensen, and de Vries (1998) investigate the question of why regulators are interested in imposing VaR regulatory measures. Presumably, VaR reporting is meant to counter systemic risk caused by asymmetric information, that is, in a perfect market there is no need for VaR reports. But, as we argue, even if VaR reveals some hidden information, VaR-induced recapitalization may not improve the value of the firm. In our opinion, the regulatory basis for VaR is not well understood and merits further study.

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Horizon Problems and Extreme Events in Financial Risk Management

Peter F. Christoffersen, Francis X. Diebold, and Til Schuermann

I. Introduction

There is no one "magic" relevant horizon for risk management. Instead, the relevant horizon will generally vary by asset class (for example, equity versus bonds), industry (banking versus insurance), position in the firm (trading desk versus chief financial officer), and motivation (private versus regulatory), among other things, and thought must be given to the relevant horizon on an application-by-application basis. But one thing is clear: in many risk management situations, the relevant horizons are long—certainly longer than just a few days—an insight incorporated, for example, in Bankers Trust's RAROC system, for which the horizon is one year.

Simultaneously, it is well known that short-horizon asset return volatility fluctuates and is highly forecastable, a phenomenon that is very much at the center of modern risk management paradigms. Much less is known, however, about the forecastability of long-horizon volatility, and the speed and pattern with which forecastability decays as the horizon lengthens. A key question arises: Is volatility forecastability important for long-horizon risk management, or is a traditional constant-volatility assumption adequate?

In this paper, we address this question, exploring the interface between long-horizon financial risk management and long-horizon volatility forecastability and, in particular, whether long-horizon volatility is forecastable enough such that volatility models are useful for long-horizon risk management. In particular, we report on recent relevant work by Diebold, Hickman, Inoue, and Schuermann (1998); Christoffersen and Diebold (1997); and Diebold, Schuermann, and Stroughair (forthcoming).

To assess long-horizon volatility forecastability, it is necessary to have a measure of long-horizon volatility, which can be obtained in a number of ways. We proceed in Section II by considering two ways of converting short-horizon volatility into long-horizon volatility: scaling and formal model-based aggregation. The defects of those procedures lead us to take a different approach in Section III, estimating volatility forecastability directly at the horizons of interest, without making assumptions about the nature of the volatility process, and arriving at a surprising conclusion: Volatility forecastability seems to decline quickly with horizon, and seems to have largely vanished beyond horizons of ten or fifteen trading days.

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If volatility forecastability is not important for risk management beyond horizons of ten or fifteen trading days, then what *is* important? The really big movements such as the U.S. crash of 1987 are still poorly understood, and ultimately the really big movements are the most important for risk management. This suggests the desirability of directly modeling the extreme tails of return densities, a task potentially facilitated by recent advances in extreme value theory. We explore that idea in Section IV, and we conclude in Section V.

II. Obtaining Long-Horizon Volatilities from Short-Horizon Volatilities: Scaling and Formal Aggregation[1]

Operationally, risk is often assessed at a short horizon, such as one day, and then converted to other horizons, such as ten days or thirty days, by scaling by the square root of horizon [for instance, as in Smithson and Minton (1996a, 1996b) or J.P. Morgan (1996)]. For example, to obtain a ten-day volatility, we multiply the one-day volatility by $\sqrt{10}$. Moreover, the horizon conversion is often significantly longer than ten days. Many banks, for example, link trading volatility measurement to internal capital allocation and risk-adjusted performance measurement schemes, which rely on annual volatility estimates. The temptation is to scale one-day volatility by $\sqrt{252}$. It turns out, however, that scaling is both inappropriate and misleading.

Scaling Works in iid Environments

Here we describe the restrictive environment in which scaling *is* appropriate. Let v_t be a log price at time *t*, and suppose that changes in the log price are independently and identically distributed,

$$v_t = v_{t-1} + \varepsilon_t \qquad \varepsilon_t \overset{iid}{\sim} (0, \sigma^2) .$$

Then the one-day return is

$$v_t - v_{t-1} = \varepsilon_t ,$$

with standard deviation σ. Similarly, the *h*-day return is

$$v_t - v_{t-h} = \sum_{i=0}^{h-1} \varepsilon_{t-i} ,$$

with variance $h\sigma^2$ and standard deviation $\sqrt{h}\sigma$. Hence, the "$\sqrt{h}$ rule": to convert a one-day standard deviation to an *h*-day standard deviation, simply scale by $\sqrt{h}$. For some applications, a percentile of the distribution of *h*-day returns may be desired; percentiles also scale by $\sqrt{h}$ if log changes are not only iid, but also normally distributed.

Scaling Fails in Non-iid Environments

The scaling rule relies on one-day returns being iid, but high-frequency financial asset returns are distinctly *not* iid. Even if high-frequency portfolio returns are conditional-mean independent (which has been the subject of intense debate in the efficient markets literature), they are certainly not conditional-variance independent, as evidenced by hundreds of recent papers documenting strong volatility persistence in financial asset returns.[2]

To highlight the failure of scaling in non-iid environments and the nature of the associated erroneous long-horizon volatility estimates, we will use a simple GARCH(1,1) process for one-day returns,

$$y_t = \sigma_t \varepsilon_t$$
$$\sigma_t^2 = \omega + \alpha y_{t-1}^2 + \beta \sigma_{t-1}^2$$
$$\varepsilon_t \sim NID(0, 1),$$

$t = 1, \ldots, T$. We impose the usual regularity and covariance stationarity conditions, $0 < \omega < \infty, \alpha \ge 0, \beta \ge 0$, and $\alpha + \beta < 1$. The key feature of the GARCH(1,1) process is that it allows for time-varying conditional volatility, which occurs when α and/or β is nonzero. The model has been fit to hundreds of financial series and has been tremendously successful empirically; hence its popularity. We hasten to add, however, that our general thesis—that scaling fails in the non-iid environments associated with high-frequency asset returns—does not depend in any way on a GARCH(1,1) structure. Rather, we focus on the GARCH(1,1) case because it has been studied the most intensely, yielding a wealth of results that enable us to illustrate the failure of scaling both analytically and by simulation.

Drost and Nijman (1993) study the temporal aggregation of GARCH processes.[3] Suppose we begin with a sample path of a one-day return series, $\{y_{(1)t}\}_{t=1}^{T}$, which follows the GARCH(1,1) process above.[4] Then Drost and Nijman show that, under regularity conditions, the corresponding sample path of h-day returns, $\{y_{(h)t}\}_{t=1}^{T/h}$, similarly follows a GARCH (1,1) process with

$$\sigma^2_{(h)t} = \omega_{(h)} + \beta_{(h)}\sigma^2_{(h)t-1} + \alpha_{(h)}y^2_{(h)t-1},$$

where

$$\omega_{(h)} = h\omega\frac{1-(\beta+\alpha)^h}{1-(\beta+\alpha)}$$

$$\alpha_{(h)} = (\beta+\alpha)^h - \beta_{(h)},$$

and $|\beta_{(h)}| < 1$ is the solution of the quadratic equation,

$$\frac{\beta_{(h)}}{1+\beta^2_{(h)}} = \frac{a(\beta+\alpha)^h - b}{a(1+(\beta+\alpha)^{2h}) - 2b},$$

where

$$a = h(1-\beta)^2 + 2h(h-1)\frac{(1-\beta-\alpha)^2(1-\beta^2-2\beta\alpha)}{(\kappa-1)(1-(\beta+\alpha)^2)} + 4\frac{(h-1-h(\beta+\alpha)+(\beta+\alpha)^h)(\alpha-\beta\alpha(\beta+\alpha))}{1-(\beta+\alpha)^2}$$

$$b = (\alpha-\beta\alpha(\beta+\alpha))\frac{1-(\beta+\alpha)^{2h}}{1-(\beta+\alpha)^2},$$

and κ is the kurtosis of y_t. The Drost-Nijman formula is neither pretty nor intuitive, but it is important, because it is the key to correct conversion of one-day volatility to h-day volatility. It is painfully obvious, moreover, that the $\sqrt{h}$ scaling formula does not look at all like the Drost-Nijman formula.

Despite the fact that the scaling formula is incorrect, it would still be very useful if it was an accurate approximation to the Drost-Nijman formula, because of its simplicity and intuitive appeal. Unfortunately, such is not the case. As $h \to \infty$, the Drost-Nijman results, which build on those of Diebold (1988), reveal that $\alpha_{(h)} \to 0$ and $\beta_{(h)} \to 0$, which is to say that temporal aggregation produces gradual disappearance of volatility fluctuations. Scaling, in contrast, *magnifies* volatility fluctuations.

A Worked Example

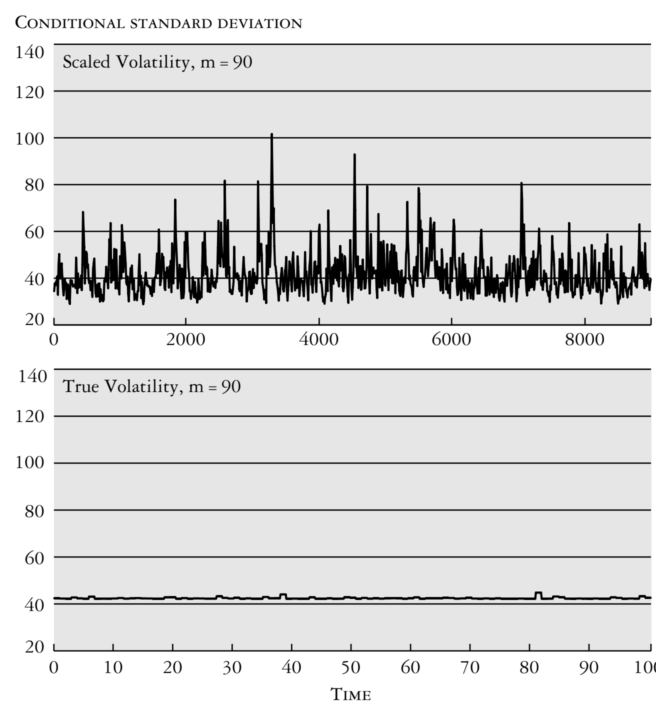
Let us examine the failure of scaling by $\sqrt{h}$ in a specific example. We parameterize the GARCH(1,1) process to be realistic for daily returns by setting $\alpha = 0.10$ and $\beta = 0.85$, which are typical of the parameter values obtained for estimated GARCH(1,1) processes. The choice of ω is arbitrary; we set $\omega = 1$.

The GARCH(1,1) process governs one-day volatility; now let us examine ninety-day volatility. In Chart 1, we show ninety-day volatilities computed in two different ways. We obtain the first (incorrect) ninety-day volatility by scaling the one-day volatility, σ_t, by $\sqrt{90}$. We obtain the second (correct) ninety-day volatility by applying the Drost-Nijman formula.

It is clear that although scaling by $\sqrt{h}$ produces volatilities that are correct on average, it magnifies the volatility fluctuations, whereas they should in fact be damped. That is, scaling produces erroneous conclusions of large fluctuations in the conditional variance of long-horizon returns, when in fact the opposite is true. Moreover, we cannot claim that the scaled volatility estimates are "conservative" in any sense; rather, they are sometimes too high and sometimes too low.

Chart 1

Ninety-Day Volatility, Scaled and Actual



Formal Aggregation Has Problems of Its Own

One might infer from the preceding discussion that formal aggregation is the key to converting short-horizon volatility estimates into good, long-horizon volatility estimates, which could be used to assess volatility forecastability. In general, such is not the case; formal aggregation has at least two problems of its own. First, temporal aggregation formulae are presently available only for restrictive classes of models; the literature has progressed little since Drost and Nijman. Second, the aggregation formulae assume the truth of the fitted model, when in fact the fitted model is simply an approximation, and the best approximation to *h*-day volatility dynamics is not likely to be what one gets by aggregating the best approximation (let alone a mediocre approximation) to one-day dynamics.

III. Model-Free Assessment of Volatility Forecastability at Different Horizons[5]

The model-dependent problems of scaling and aggregating daily volatility measures motivate the model-free investigation of volatility forecastability in this section. If the true process is GARCH(1,1), we know that volatility is forecastable at all horizons, although forecastability will decrease with horizon in accordance with the Drost-Nijman formula. But GARCH is only an approximation, and in this section we proceed to develop procedures that allow for assessment of volatility forecastability across horizons with no assumptions made on the underlying volatility model.

The Basic Idea

Our model-free methods build on the methods for evaluation of interval forecasts developed by Christoffersen (forthcoming). Interval forecasting is very much at the heart of modern financial risk management. The industry standard value-at-risk measure is effectively the boundary of a one-sided interval forecast, and just as the adequacy of a value-at-risk forecast depends crucially on getting the volatility dynamics right, the same is true for interval forecasts more generally.

Suppose that we observe a sample path $\{y_t\}_{t=1}^{T}$ of the asset return series y_t and a corresponding sequence of one-step-ahead interval forecasts, $\{(L_{t|t-1}(p), U_{t|t-1}(p))\}_{t=1}^{T}$, where $L_{t|t-1}(p)$ and $U_{t|t-1}(p)$ denote the lower and upper limits of the interval forecast for time t made at time $t-1$ with desired coverage probability p. We can think of $L_{t|t-1}(p)$ as a value-at-risk measure, and $U_{t|t-1}(p)$ as a measure of potential upside. The interval forecasts are subscripted by t as they will vary through time in general: in volatile times a good interval forecast should be wide and in tranquil times it should be narrow, keeping the coverage probability, p, fixed.

Now let us formalize matters slightly. Define the *hit sequence*, I_t, as

$$I_t = \begin{cases} 1, \; if \; y_t \in [L_{t|t-1}(p), U_{t|t-1}(p)] \\ 0, \; otherwise, \end{cases}$$

for $t = 1, 2, \ldots, T$. We will say that a sequence of interval forecasts has correct *unconditional coverage* if $E[I_t] = p$ for all t, which is the standard notion of "correct coverage."

Correct unconditional coverage is appropriately viewed as a necessary condition for adequacy of an interval forecast. It is not sufficient, however. In particular, in the presence of conditional heteroskedasticity and other higher order dynamics, it is important to check for adequacy of conditional coverage, which is a stronger concept. We will say that a sequence of interval forecasts has correct *conditional coverage with respect to an information set* Ω_{t-1} if $E[I_t|\Omega_{t-1}] = p$ for all t. The key result is that if $\Omega_{t-1} = \{I_{t-1}, I_{t-2}, \ldots, I_1\}$, then correct conditional coverage is equivalent to $\{I_t\} \overset{iid}{\sim} \text{Bernoulli}(p)$, which can readily be tested.

Consider now the case where no volatility dynamics are present. The optimal interval forecast is then constant, and given by $\{(L(p), U(p))\}, t = 1, \ldots, T$. In that case, testing for correct conditional coverage will reveal no evidence of dependence in the hit sequence, and it is exactly the independence part of the iid $\text{Bernoulli}(p)$ criterion that is designed to pick up volatility dynamics. If, however, volatility dynamics *are* present but ignored by a forecaster who erroneously uses the constant $\{L(p), U(p)\}$ forecast, then a test for dependence in the hit sequence will reject the constant interval as an appropriate forecast: the ones and zeros in the hit sequence will tend to appear in time-dependent clusters corresponding to tranquil and volatile times.

It is evident that the interval forecast evaluation framework can be turned into a framework for assessing volatility forecastability: if a naive, constant interval forecast produces a dependent hit sequence, then volatility dynamics are present.

Measuring and Testing Dependence in the Hit Sequence

Now that we have established the close correspondence between the presence of volatility dynamics and dependence in the hit sequence from a constant interval forecast, it is time to discuss the measurement and testing of this dependence. We discuss two approaches.

First, consider a runs test, which is based on counting the number of strings, or *runs,* of consecutive zeros and ones in the hit sequence. If too few runs are observed (for example, 0000011111), the sequence exhibits positive correlation. Under the null hypothesis of independence, the exact finite sample distribution of the number of runs in the sequence has been tabulated by David (1947), and the corresponding test has been shown by Lehmann (1986) to be uniformly most powerful against a first-order Markov alternative.

We complement the runs test by a second measure, which has the benefit of being constrained to the interval [-1,1] and thus easily comparable across horizons and sequences. Let the hit sequence be first-order Markov with an arbitrary transition probability matrix. Then dependence is fully captured by the nontrivial eigenvalue, which is simply $S \equiv \pi_{11} - \pi_{01}$, where π_{ij} is the probability of a j following an i in the hit sequence. S is a natural persistence measure and has been studied by Shorrocks (1978) and Sommers and Conlisk (1979). Note that under independence $\pi_{01} = \pi_{11}$, so $S = 0$, and conversely, under strong positive persistence π_{11} will be much larger than π_{01}, so S will be large.

An Example: The Dow Jones Composite Stock Index

We now put the volatility testing framework to use in an application to the Dow Jones Composite Stock Index, which comprises sixty-five major stocks (thirty industrials, twenty transportations, and fifteen utilities) on the New York Stock Exchange. The data start on January 1, 1974, and continue through April 2, 1998, resulting in 6,327 daily observations.

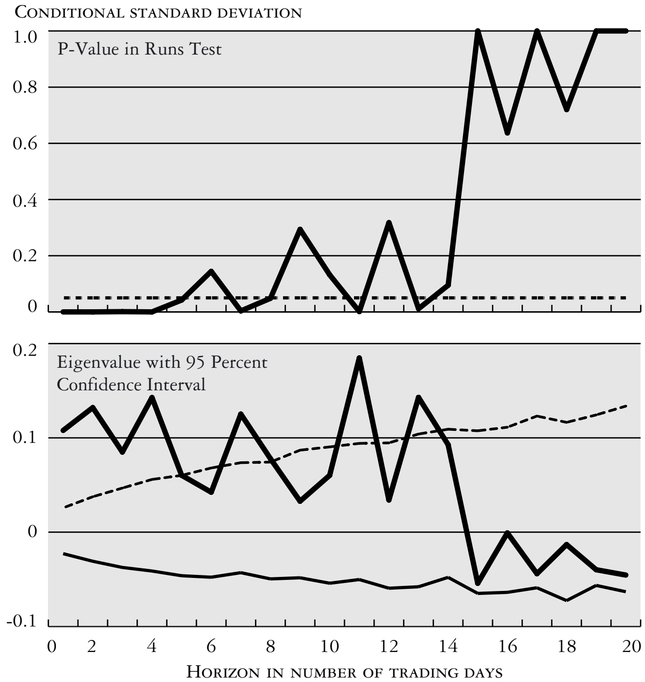
We examine asset return volatility forecastability as a function of the horizon over which the returns are calculated. We begin with daily returns and then aggregate to obtain nonoverlapping h-day returns, $h = 1, 2, 3, \ldots, 20$. We set $\{L(p), U(p)\}$ equal to ± 2 standard deviations and then compute the hit sequences. Because the standard deviation varies across horizons, we let the interval vary correspondingly. Notice that p might vary across horizons, but such variation is irrelevant: we are interested only in dependence of the hit sequence, not its mean.

At each horizon, we measure volatility forecastability using the P-value of the runs test—that is, the probability of obtaining a sample that is less likely to conform to the null hypothesis of independence than does the sample at hand. If the P-value is less than 5 percent, we reject the null of independence at that particular horizon. The top panel of Chart 2 on the next page shows the P-values across horizons of one through twenty trading days. Notice that despite the jaggedness of the line, a distinct pattern emerges: at short horizons of up to a week, the P-value is very low and thus there is clear evidence of volatility forecastability. At medium horizons of two to three weeks, the P-value jumps up and down, making reliable inference difficult. At longer horizons, greater than three weeks, we find no evidence of volatility forecastability.

We also check the nontrivial eigenvalue. In order to obtain a reliable finite-sample measure of statistical significance at each horizon, we use a simulation-based resampling procedure to compute the 95 percent confidence interval under the null hypothesis of no dependence in the hit sequence (that is, the eigenvalue is zero). In the bottom panel of Chart 2, we plot the eigenvalue at each

Chart 2

VOLATILITY PERSISTENCE ACROSS HORIZONS IN THE DOW JONES COMPOSITE INDEX



Notes: The hit sequence is defined relative to a constant ±2 standard deviation interval at each horizon. The top panel shows the P-value for a runs test of the hypothesis that the hit sequence is independent. The horizontal line corresponds to a 5 percent significance level. The bottom panel shows the nontrivial eigenvalue from a first-order Markov process fit to the hit sequence. The 95 percent confidence interval is computed by simulation.

horizon along with its 95 percent confidence interval. The qualitative pattern that emerges for the eigenvalue is the same as for the runs test: volatility persistence is clearly present at horizons less than a week, probably present at horizons between two and three weeks, and probably not present at horizons beyond three weeks.

MULTI-COUNTRY ANALYSIS OF EQUITY, FOREIGN EXCHANGE, AND BOND MARKETS

Christoffersen and Diebold (1997) assess volatility forecastability as a function of horizon for many more assets and countries. In particular, they analyze stock, foreign exchange, and bond returns for the United States, the United Kingdom, Germany, and Japan, and they obtain results very similar to those presented above for the Dow Jones composite index of U.S. equities.

For all returns, the finite-sample P-values of the runs tests of independence tend to rise with the aggregation level, although the specifics differ somewhat depending on the particular return examined. As a rough rule of thumb, we summarize the results as saying that for aggregation levels of less than ten trading days we tend to reject independence, which is to say that return volatility is significantly forecastable, and conversely for aggregation levels greater than ten days.

The estimated transition matrix eigenvalues tell the same story: at very short horizons, typically from one to ten trading days, the eigenvalues are significantly positive, but they decrease quickly, and approximately monotonically, with the aggregation level. By the time one reaches ten-day returns—and often substantially before—the estimated eigenvalues are small and statistically insignificant, indicating that volatility forecastability has vanished.

IV. FORECASTING EXTREME EVENTS[6]

The quick decay of volatility forecastability as the forecast horizon lengthens suggests that, if the risk management horizon is more than ten or fifteen trading days, less energy should be devoted to modeling and forecasting volatility and more energy should be devoted to modeling directly the extreme tails of return densities, a task potentially facilitated by recent advances in extreme value theory (EVT).[7] The theory typically requires independent and identically distributed observations, an assumption that appears reasonable for horizons of more than ten or fifteen trading days.

Let us elaborate. Financial risk management is intimately concerned with tail quantiles (for example, the value of the return, y, such that $P(Y > y) = .05$) and tail probabilities (for example, $P(Y > y)$, for a large value y). *Extreme* quantiles and probabilities are of particular interest, because the ability to assess them accurately translates into the ability to manage extreme financial risks effectively, such as those associated with currency crises, stock market crashes, and large bond defaults.

Unfortunately, traditional parametric statistical and econometric methods, typically based on estimation of entire densities, may be ill-suited to the assessment of extreme quantiles and event probabilities. Traditional parametric methods implicitly strive to produce a good fit in regions where most of the data fall, potentially at the expense of a good fit in the tails, where, by definition, few observations fall. Seemingly sophisticated nonparametric methods of density estimation, such as kernel smoothing, are also well known to perform poorly in the tails.

It is common, moreover, to require estimates of quantiles and probabilities not only *near* the boundary of the range of observed data, but also *beyond* the boundary. The task of estimating such quantiles and probabilities would seem to be hopeless. A key idea, however, emerges from EVT: one can estimate extreme quantiles and probabilities by fitting a "model" to the empirical survival function of a set of data using only the extreme event data rather than all the data, thereby fitting the tail and only the tail.[8] The approach has a number of attractive features, including:

- the estimation method is tailored to the object of interest—the tail of the distribution—rather than the center of the distribution, and
- an arguably reasonable functional form for the tail can be formulated from a priori considerations.

The upshot is that the methods of EVT offer hope for progress toward the elusive goal of reliable estimates of extreme quantiles and probabilities.

Let us briefly introduce the basic framework. EVT methods of tail estimation rely heavily on a power law assumption, which is to say that the tail of the survival function is assumed to be a power law times a slowly varying function:

$$P(Y > y) = k(y)\ y^{-\alpha},$$

where the "tail index," α, is a parameter to be estimated. That family includes, for example, α-stable laws with $\alpha < 2$ (but not the Gaussian case, $\alpha = 2$).

Under the power law assumption, we can base an estimator of α directly on the extreme values. The most popular, by far, is due to Hill (1975). It proceeds by ordering the observations with $y_{(1)}$ the largest, $y_{(2)}$ the second largest, and so on, and forming an estimator based on the difference between the average of the m largest log returns and the m-th largest log return:

$$\alpha = \left(\left(\frac{1}{m}\sum_{i=1}^{m} ln(y_{(i)})\right) - ln(y_{(m)})\right)^{-1}.$$

It is a simple matter to convert an estimate of α into estimates of the desired quantiles and probabilities. The Hill estimator has been used in empirical financial settings, ranging from early work by Koedijk, Schafgans, and de Vries (1990) to more recent work by Danielsson and de Vries (1997). It also has good theoretical properties; it can be shown, for example, that it is consistent and asymptotically normal, assuming the data are iid and that m grows at a suitable rate with sample size.

But beware: if tail estimation via EVT offers opportunities, it is also fraught with pitfalls, as is any attempt to estimate low-frequency features of data from short historical samples. This has been recognized in other fields, such as the empirical finance literature on long-run mean reversion in asset returns (for instance, Campbell, Lo, and MacKinlay [1997, Chapter 2]). The problem as relevant for the present context—applications of EVT in financial risk management—is that for performing statistical inference on objects such as a "once every hundred years" quantile, the relevant measure of sample size is likely better approximated by the number of nonoverlapping hundred-year intervals in the data set than by the actual number of data points. From that perspective, our data samples are terribly small relative to the demands placed on them by EVT.

Thus, we believe that best-practice applications of EVT to financial risk management will benefit from awareness of its limitations, as well as the strengths. When the smoke clears, the contribution of EVT remains basic and useful: it helps us to draw smooth curves through the extreme tails of empirical survival functions in a way that is consistent with powerful theory. Our point is simply that we should not ask more of the theory than it can deliver.

V. Concluding Remarks

If volatility is forecastable at the horizons of interest, then volatility forecasts are relevant for risk management. But our results indicate that if the horizon of interest is more than ten or fifteen trading days, depending on the asset class, then volatility is effectively not forecastable. Our results question the assumptions embedded in popular risk management paradigms, which effectively assume much greater volatility forecastability at long horizons than appears consistent with the data, and suggest that for improving long-horizon risk management, attention is better focused elsewhere. One such area is the modeling of extreme events, the probabilistic nature of which remains poorly understood, and for which recent developments in extreme value theory hold promise.

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ENDNOTES

We thank Beverly Hirtle for insightful and constructive comments, but we alone are responsible for remaining errors. The views expressed in this paper are those of the authors and do not necessarily reflect those of the International Monetary Fund.

1. This section draws on Diebold, Hickman, Inoue, and Schuermann (1997, 1998).

2. See, for example, the surveys of volatility modeling in financial markets by Bollerslev, Chou, and Kroner (1992) and Diebold and Lopez (1995).

3. More precisely, they define and study the temporal aggregation of *weak* GARCH processes, a formal definition of which is beyond the scope of this paper. Technically inclined readers should read "weak GARCH" whenever they encounter the word "GARCH" in this paper.

4. Note the new and more cumbersome, but necessary, notation: the subscript, which keeps track of the aggregation level.

5. This section draws on Christoffersen and Diebold (1997).

6. This section draws on Diebold, Schuermann, and Stroughair (forthcoming).

7. See the recent book by Embrechts, Klüppelberg, and Mikosch (1997), as well as the papers introduced by Paul-Choudhury (1998).

8. The survival function is simply 1 minus the cumulative density function, $1 - F(y)$. Note, in particular, that because $F(y)$ approaches 1 as y grows, the survival function approaches 0.

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Methods for Evaluating Value-at-Risk Estimates

Jose A. Lopez

I. Current Regulatory Framework

In August 1996, the U.S. bank regulatory agencies adopted the market risk amendment (MRA) to the 1988 Basle Capital Accord. The MRA, which became effective in January 1998, requires that commercial banks with significant trading activities set aside capital to cover the market risk exposure in their trading accounts. (For further details on the market risk amendment, see *Federal Register* [1996].) The market risk capital requirements are to be based on the value-at-risk (VaR) estimates generated by the banks' own risk management models.

In general, such risk management, or VaR, models forecast the distributions of future portfolio returns. To fix notation, let y_t denote the log of portfolio value at time t. The k-period-ahead portfolio return is $\varepsilon_{t+k} = y_{t+k} - y_t$. Conditional on the information available at time t, ε_{t+k} is a random variable with distribution f_{t+k}. Thus, VaR model m is characterized by f_{mt+k}, its forecast of the distribution of the k-period-ahead portfolio return.

VaR estimates are the most common type of forecast generated by VaR models. A VaR estimate is simply a specified quantile (or critical value) of the forecasted f_{mt+k}. The VaR estimate at time t derived from model m for a k-period-ahead return, denoted $VaR_{mt}(k,\alpha)$, is the critical value that corresponds to the lower α percent tail of f_{mt+k}. In other words, VaR estimates are forecasts of the maximum portfolio loss that could occur over a given holding period with a specified confidence level.

Under the "internal models" approach embodied in the MRA, regulatory capital against market risk exposure is based on VaR estimates generated by banks' own VaR models using the standardizing parameters of a ten-day holding period $(k = 10)$ and 99 percent coverage $(\alpha = 1)$. A bank's market risk capital charge is thus based on its own estimate of the potential loss that would not be exceeded with 1 percent certainty over the subsequent two-week period. The market risk capital that bank m must hold for time $t+1$, denoted MCR_{mt+1}, is set as the larger of $VaR_{mt}(10,1)$ or a multiple of the average of the previous sixty $VaR_{mt}(10,1)$ estimates, that is,

$$MRC_{mt+1} = max\left[VaR_{mt}(10,1);\ S_{mt} \times \frac{1}{60}\sum_{i=0}^{59} VaR_{mt-i}(10,1)\right] + SR_{mt},$$

where S_{mt} is a multiplication factor and SR_{mt} is an additional capital charge for the portfolio's idiosyncratic credit risk. Note that under the current framework $S_{mt} \geq 3$.

The S_{mt} multiplier explicitly links the accuracy of a bank's VaR model to its capital charge by varying over time. S_{mt} is set according to the accuracy of model m's VaR

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estimates for a one-day holding period ($k = 1$) and 99 percent coverage, denoted $VaR_{mt}(1,1)$ or simply VaR_{mt}. S_{mt} is a step function that depends on the number of exceptions (that is, occasions when the portfolio return ε_{t+1} is less than VaR_{mt}) observed over the last 250 trading days. The possible number of exceptions is divided into three zones. Within the green zone of four or fewer exceptions, a VaR model is deemed "acceptably accurate," and S_{mt} remains at its minimum value of three. Within the yellow zone of five to nine exceptions, S_{mt} increases incrementally with the number of exceptions. Within the red zone of ten or more exceptions, the VaR model is deemed to be "inaccurate," and S_{mt} increases to its maximum value of four.

II. Alternative Evaluation Methods

Given the obvious importance of VaR estimates to banks and now their regulators, evaluating the accuracy of the models underlying them is a necessary exercise. To date, two hypothesis-testing methods for evaluating VaR estimates have been proposed: the binomial method, currently the quantitative standard embodied in the MRA, and the interval forecast method proposed by Christoffersen (forthcoming). For these tests, the null hypothesis is that the VaR estimates in question exhibit a specified property characteristic of accurate VaR estimates. If the null hypothesis is rejected, the VaR estimates do not exhibit the specified property, and the underlying VaR model can be said to be "inaccurate." If the null hypothesis is not rejected, then the model can be said to be "acceptably accurate."

However, for these evaluation methods, as with any hypothesis test, a key issue is their statistical power, that is, their ability to reject the null hypothesis when it is incorrect. If the hypothesis tests exhibit low power, then the probability of misclassifying an inaccurate VaR model as "acceptably accurate" will be high. This paper examines the power of these tests within the context of a simulation exercise.

In addition, an alternative evaluation method that is not based on a hypothesis-testing framework, but instead uses standard forecast evaluation techniques, is proposed. That is, the accuracy of VaR estimates is gauged by how well they minimize a loss function that represents the regulators' concerns. Although statistical power is not relevant for this evaluation method, the related issues of comparative accuracy and model misclassification are examined within the context of a simulation exercise. The simulation results are presented below, after the three evaluation methods are described. (See Lopez [1998] for a more complete discussion.)

Evaluation of VaR Estimates Based on the Binomial Distribution

Under the MRA, banks will report their VaR estimates to their regulators, who observe when actual portfolio losses exceed these estimates. As discussed by Kupiec (1995), assuming that the VaR estimates are accurate, such exceptions can be modeled as independent draws from a binomial distribution with a probability of occurrence equal to 1 percent. Accurate VaR estimates should exhibit the property that their unconditional coverage $\alpha^* = x/250$, where x is the number of exceptions, equals 1 percent. Since the probability of observing x exceptions in a sample of size 250 under the null hypothesis is

$$Pr(x) = \binom{250}{x} 0.01^x \times 0.99^{250-x},$$

the appropriate likelihood ratio statistic for testing whether $\alpha^* = 0.01$ is

$$LR_{uc} = 2[\log(\alpha^{*x}(1-\alpha^*)^{250-x}) - \log(0.01^x \times 0.99^{250-x})].$$

Note that the LR_{uc} test is uniformly most powerful for a given sample size and that the statistic has an asymptotic $\chi^2(1)$ distribution.

Evaluation of VaR Estimates Using the Interval Forecast Method

VaR estimates are also interval forecasts of the lower 1 percent tail of f_{t+1}, the one-step-ahead return distribution. Interval forecasts can be evaluated conditionally or unconditionally, that is, with or without reference to the information available at each point in time. The LR_{uc} test is an unconditional test since it simply counts exceptions over the entire period. However, in the presence of variance dynamics, the conditional accuracy of interval forecasts is an important issue. Interval forecasts that ignore variance dynamics may have correct unconditional coverage, but at any given time, they will have incorrect conditional coverage. In such cases, the LR_{uc} test is of limited use since it will classify inaccurate VaR estimates as "acceptably accurate."

The LR_{cc} test, adapted from the more general test proposed by Christoffersen (forthcoming), is a test of correct conditional coverage. Given a set of VaR estimates, the indicator variable I_{mt+1} is constructed as

$$I_{mt+1} = \begin{cases} 1 \;\; if \;\; \varepsilon_{t+1} < VaR_{mt} \\ 0 \;\; if \;\; \varepsilon_{t+1} \geq VaR_{mt} \end{cases}.$$

Since accurate VaR estimates exhibit the property of correct conditional coverage, the I_{mt+1} series must exhibit both correct unconditional coverage and serial independence. The LR_{cc} test is a joint test of these two properties. The relevant test statistic is $LR_{cc} = LR_{uc} + LR_{ind}$, which is asymptotically distributed $\chi^2(2)$. The LR_{ind} statistic is the likelihood ratio statistic for the null hypothesis of serial independence against the alternative of first-order Markov dependence.

Evaluation of VaR Estimates Using Regulatory Loss Functions

The loss function evaluation method proposed here is not based on a hypothesis-testing framework, but rather on assigning to VaR estimates a numerical score that reflects specific regulatory concerns. Although this method forgoes the benefits of statistical inference, it provides a measure of relative performance that can be used to monitor the performance of VaR estimates.

To use this method, the regulatory concerns of interest must be translated into a loss function. The general form of these loss functions is

$$C_{mt+1} = \begin{cases} f(\varepsilon_{t+1}, VaR_{mt}) \;\; if \;\; \varepsilon_{t+1} < VaR_{mt} \\ g(\varepsilon_{t+1}, VaR_{mt}) \;\; if \;\; \varepsilon_{t+1} \geq VaR_{mt} \end{cases},$$

where $f(x,y)$ and $g(x,y)$ are functions such that $f(x,y) \geq g(x,y)$ for a given y. The numerical scores are constructed with a negative orientation, that is, lower values of C_{mt+1} are preferred since exceptions are given higher scores than nonexceptions. Numerical scores are generated for individual VaR estimates, and the score for the complete regulatory sample is

$$C_m = \sum_{i=1}^{250} C_{mt+i}.$$

Under very general conditions, accurate VaR estimates will generate the lowest possible numerical score. Once a loss function is defined and C_m is calculated, a benchmark can be constructed and used to evaluate the performance of a set of VAR estimates. Although many regulatory loss functions can be constructed, two are described below (see diagram).

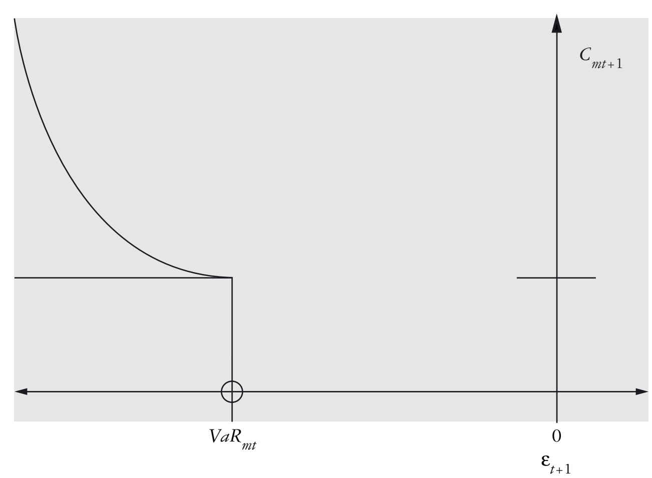
Loss Function Implied by the Binomial Method

The loss function implied by the binomial method is

$$C_{mt+1} = \begin{cases} 1 \;\; if \;\; \varepsilon_{t+1} < VaR_{mt} \\ 0 \;\; if \;\; \varepsilon_{t+1} \geq VaR_{mt} \end{cases}.$$

Note that the appropriate benchmark is the expected value of C_{mt+1}, which is $E[C_{mt+1}] = 0.01$, and for the full sample, $E[C_m] = 2.5$. As before, only the number of exceptions is of interest, and the same information contained in the binomial method is included in this loss function.

Loss Functions of Interest



Notes: The diagram graphs both the binomial and the magnitude loss functions. The binomial loss function is equal to 1 for $\varepsilon_{t+1} < VaR_{mt}$ and zero otherwise. For the magnitude loss function, a quadratic term is added to the binomial loss function for $\varepsilon_{t+1} < VaR_{mt}$.

Loss Function That Addresses the Magnitude of the Exceptions
As noted by the Basle Committee on Banking Supervision (1996), the magnitude as well as the number of exceptions are a matter of regulatory concern. This concern can be readily incorporated into a loss function by introducing a magnitude term. Although several are possible, a quadratic term is used here, such that

$$C_{mt+1} = \begin{cases} 1 + (\varepsilon_{t+1} - VaR_{mt})^2 & if \ \varepsilon_{t+1} < VaR_{mt} \\ 0 & if \ \varepsilon_{t+1} \geq VaR_{mt} \end{cases}.$$

Thus, as before, a score of one is imposed when an exception occurs, but now, an additional term based on its magnitude is included. The numerical score increases with the magnitude of the exception and can provide additional information on how the underlying VaR model forecasts the lower tail of the underlying f_{t+1} distribution. Unfortunately, the benchmark based on the expected value of C_{mt+1} cannot be determined easily, because the f_{t+1} distribution is unknown. However, a simple, operational benchmark can be constructed and is discussed in Section III.

Simulation Exercise
To analyze the ability of the three evaluation methods to gauge the accuracy of VaR estimates and thus avoid VaR model misclassification, a simulation exercise is conducted. For the two hypothesis-testing methods, this amounts to analyzing the power of the statistical tests, that is, determining the probability with which the tests reject the null hypothesis when it is incorrect. With respect to the loss function method, its ability to evaluate VaR estimates is gauged by how frequently the numerical score for VaR estimates generated from the true data-generating process (DGP) is lower than the score for VaR estimates from alternative models. If the method is capable of distinguishing between these scores, then the degree of VaR model misclassification will be low.

In the simulation exercise, the portfolio value y_{t+1} is specified as $y_{t+1} = y_t + \varepsilon_{t+1}$, where the portfolio return ε_{t+1} is generated by a GARCH(1,1)-normal process. That is, h_{t+1}, the variance of ε_{t+1}, has dynamics of the form $h_{t+1} = 0.075 + 0.10\varepsilon_t^2 + 0.85h_t$. The true DGP is one of eight VaR models evaluated and is designated as the "true" model, or model 1.

The next three alternative models are homoskedastic VaR models. Model 2 is simply the standard normal distribution, and model 3 is the normal distribution with a variance of 1½. Model 4 is the *t*-distribution with six degrees of freedom, which has fatter tails than the normal distribution and an unconditional variance of 1½.

The next three models are heteroskedastic VaR models. For models 5 and 6, the underlying distribution is the normal distribution, and h_{mt+1} evolves over time as an exponentially weighted moving average of past squared returns, that is,

$$h_{mt+1} = (1-\lambda)\sum_{i=0}^{\infty}\lambda^i\varepsilon_{t-i}^2 = \lambda h_{mt} + (1-\lambda)\varepsilon_t^2 .$$

This type of VaR model, which is used in the well-known RiskMetrics calculations (see J.P. Morgan [1996]), is calibrated here by setting λ equal to 0.94 and 0.99 for models 5 and 6, respectively. Model 7 has the same variance dynamics as the true model, but instead of using the normal distribution, it uses the *t*-distribution with six degrees of freedom. Model 8 is the VaR model based on historical simulation using 500 observations, that is, using the past 500 observed returns, the α percent VaR estimate is observation number $5*\alpha$ of the sorted returns.

In the table, panel A presents the power analysis of the hypothesis-testing methods. The simulation results indicate that the hypothesis-testing methods can have relatively low power and thus a relatively high probability of misclassifying inaccurate VaR estimates as "acceptably accurate." Specifically, the tests have low power against the calibrated normal models (models 5 and 6) since their smoothed variances are quite similar to the true GARCH variances. The power against the homoskedastic alternatives is quite low as well.

For the proposed loss function method, the simulation results indicate that the degree of model misclassification generally mirrors that of the other methods, that is, this method has a low-to-moderate ability to distinguish between the true and alternative VaR models. However, in certain cases, it provides additional useful information on

SIMULATION RESULTS FOR GARCH(1,1)-NORMAL DGP
Units: percent

	Models						
	Homoskedastic			Heteroskedastic			Historical
	2	3	4	5	6	7	8
PANEL A: POWER OF THE LR_{UC} AND LR_{CC} AGAINST ALTERNATIVE VAR MODELS[a]							
LR_{uc}	52.3	21.4	30.5	5.1	10.3	81.7	23.2
LR_{cc}	56.3	25.4	38.4	6.7	11.9	91.6	33.1
PANEL B: ACCURACY OF VAR ESTIMATES USING REGULATORY LOSS FUNCTIONS[b]							
Loss function							
Binomial	91.7	41.3	18.1	52.2	48.9	0	38.0
Magnitude	96.5	56.1	29.1	75.3	69.4	0	51.5

Notes: The results are based on 1,000 simulations. Model 1 is the true data-generating process, $\varepsilon_{t+1} | \Omega_t \sim N(0, h_{t+1})$, where $h_{t+1} = 0.075 + 0.10\varepsilon_t^2 + 0.85h_t$. Models 2, 3, and 4 are the homoskedastic models $N(0, 1)$, $N(0,1.5)$, and t (6), respectively. Models 5 and 6 are the two calibrated heteroskedastic models with the normal distribution, and model 7 is a GARCH(1,1) -t (6) model with the same parameter values as model 1. Model 8 is the historical simulation model based on the previous 500 observations.

[a]The size of the tests is set at 5 percent using finite-sample critical values.

[b]Each row represents the percentage of simulations for which the alternative VaR estimates have a higher numerical score than the "true" model, that is, the percentage of the simulations for which the alternative VaR estimates are correctly classified as inaccurate.

the accuracy of the VaR estimates under the defined loss function. For example, note that the magnitude loss function is relatively more correct in classifying VaR estimates than the binomial loss function. This result is not surprising given that it incorporates the additional information on the magnitude of the exceptions into the evaluation. The ability to use such additional information, as well as the flexibility with respect to the specification of the loss function, makes a reasonable case for the use of the loss function method in the regulatory evaluation of VaR estimates.

III. IMPLEMENTATION OF THE LOSS FUNCTION METHOD

Under the current regulatory framework, regulators observe $\{\varepsilon_{t+i}, VaR_{mt+i}\}_{i=1}^{250}$ for bank m and thus can construct, under the magnitude loss function, C_m. However, for a realized value C_m^*, aside from the number of exceptions, not much inference on the performance of these VaR estimates is available. It is unknown whether C_m^* is a "high" or "low" number.

To create a comparative benchmark, the distribution of C_m, which is a random variable due to the random observed portfolio returns, can be constructed. Since each observation has its own distribution, additional assumptions must be imposed in order to analyze $f(C_m)$, the distribution of C_m. Specifically, the observed returns can be assumed to be independent and identically distributed (iid); that is, $\varepsilon_{t+1} \sim f$. This is quite a strong assumption, especially given the heteroskedasticity often found in financial time series. However, the small sample size of 250 mandated by the MRA allows few other choices.

Having made the assumption that the observed returns are iid, their empirical distribution $\hat{f}(\varepsilon_{t+1})$ can be estimated parametrically, that is, a specific distributional form is assumed, and the necessary parameters are estimated from the available data. For example, if the returns are assumed to be normally distributed with zero mean, the variance can be estimated such that $\hat{f}(\varepsilon_{t+1})$ is $N(0, \hat{\sigma}^2)$.

Once $\hat{f}(\varepsilon_{t+1})$ has been determined, the empirical distribution of the numerical score C_m under the distributional assumptions, denoted $\hat{f}(C_m)$, can be generated since the distribution of the observed returns and the corresponding VaR estimates are now available. For example, if $\varepsilon_{t+1} \sim N(0, \hat{\sigma}^2)$, then the corresponding VaR estimates are $VaR_{\hat{f}t} = -2.32\hat{\sigma}$. Using this information, $\hat{f}(C_m)$ can then be constructed via simulation by forming 1,000 values of the numerical score C_m, each based on 250 draws from $\hat{f}(\varepsilon_{t+1})$ and the corresponding VaR estimates.

Once $\hat{f}(C_m)$ has been generated, the empirical quantile $\hat{q}_m = \hat{F}(C_m^*)$, where $\hat{F}(C_m)$ is the cumulative distribution function of $\hat{f}(C_m)$, can be calculated for the observed value C_m^*. This empirical quantile provides a performance benchmark, based on the distributional assumptions, that can be incorporated into the evaluation of the underlying VaR estimates. In order to make this benchmark operational, the regulator should select a threshold quantile above which concerns regarding the performance of the VaR estimates are raised. This decision should be based both on the regulators' preferences and the severity of the distributional assumptions used. If $\hat{q}_m$ is below the threshold that regulators believe is appropriate, say, below 80 percent, then

C_m* is "typical" under both the assumptions on $\hat{f}(\varepsilon_{t+1})$ and the regulators' preferences. If $\hat{q}_m$ is above the threshold, then C_m* can be considered atypical, and the regulators should take a closer look at the underlying VaR model.

Note that this method for evaluating VaR estimates does not replace the hypothesis-testing methods, but instead provides complementary information, especially regarding the magnitude of the exceptions. In addition, the flexibility of this method permits many other concerns to be incorporated into the analysis via the choice of the loss function.

IV. Conclusion

As implemented in the United States, the market risk amendment to the Basle Capital Accord requires that commercial banks with significant trading activity provide their regulators with VaR estimates from their own internal models. The VaR estimates will be used to determine the banks' market risk capital requirements. This development clearly indicates the importance of evaluating the accuracy of VaR estimates from a regulatory perspective.

The binomial and interval forecast evaluation methods are based on a hypothesis-testing framework and are used to test the null hypothesis that the reported VaR estimates are "acceptably accurate," where accuracy is defined by the test conducted. As shown in the simulation exercise, the power of these tests can be low against reasonable alternative VaR models. This result does not negate their usefulness, but it does indicate that the inference drawn from this analysis has limitations.

The proposed loss function method is based on assigning numerical scores to the performance of the VaR estimates under a loss function that reflects the concerns of the regulators. As shown in the simulation exercise, this method can provide additional useful information on the accuracy of the VaR estimates. Furthermore, it allows the evaluation to be tailored to specific interests that regulators may have, such as the magnitude of the observed exceptions. Since these methods provide complementary information, all three could be useful in the regulatory evaluation of VaR estimates.

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Commentary

Beverly Hirtle

I am very pleased to speak here today and to comment on these three very interesting and constructive papers dealing with value-at-risk modeling issues. In my view, each paper is an excellent example of what academic research has to tell practitioners and supervisors about the practical problems of constructing value-at-risk models. Each paper examines a particular aspect of value-at-risk modeling or validation, and offers important insights into the very real issues that can arise when specifying these models and when considering their use for supervisory purposes. In that sense, the papers make important contributions to our understanding of how these models are likely to work in practice.

Danielsson, de Vries, and Jørgensen

The Danielsson, de Vries, and Jørgensen paper examines some key issues surrounding the question of how well current state-of-the-art, value-at-risk models capture the behavior of the tails of the distribution of profit and loss, that is, those rare but important instances in which large losses are realized. As the paper points out, this question is a fundamental one in the world of value-at-risk modeling, since both risk managers and supervisors are presumably quite concerned about such events. In fact, one of the key motivations for the development of value-at-risk models was to be able to answer the question, If something goes really wrong, how much money am I likely to lose? Put more technically, risk managers and the senior management of financial institutions wanted to be able to assess both the *probability* that large losses would occur and the *extent* of losses in the event of unfortunate movements in markets. When supervisors began considering the use of these models for risk-based capital purposes, the fundamental questions were much the same. Thus, for all these reasons, the ability to model the tails of the distribution accurately is an important concern.

As the Danielsson et al. paper shows, this ability is especially key when there is suspicion that the distribution might feature “fat tails.” As you know, the phrase fat tails refers to the situation in which the *actual* probability of experiencing a loss of a given size—generally, a large loss that would be considered to have a low probability of occurring—is greater than the probability predicted by the distribution *assumed* in the value-at-risk model. Obviously, this disparity would be a matter of concern for risk managers and for supervisors who would like to use value-at-risk models for risk-based capital purposes.

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The paper suggests a method for addressing this situation. I will not go into the details of the analysis, but the paper proposes a method of estimating the overall distribution of potential profits and losses that essentially combines fairly standard methods for specifying the middle of the distribution with an alternative approach for estimating the tails. The paper then tests this modeling approach using random portfolios composed of U.S. equities and concludes that, at least for these portfolios, the "tail estimator" approach outperforms value-at-risk models based on a normal distribution and historical simulation.

When thinking about the practical implications of the proposed tail estimator technique, at least one significant question occurs to me. The empirical experiments reported in the paper are based on a fairly large data sample of 1,500 trading-day observations, or about six years of historical data. While this long data history may be available for certain instruments, it strikes me that these are more data than are likely to be available for at least some of the key risk factors that could influence the behavior of many financial institutions' portfolios, particularly when regime shifts and major market breaks are taken into account. Thus, the question that arises is, How well would the proposed tail estimator approach perform relative to more standard value-at-risk techniques when used on an historical data set more typical of the size used by financial institutions in their value-at-risk models, say, one to three years of data? At its heart, the question I am asking is whether the tail estimator approach would continue to perform significantly better than other value-at-risk methods under the more typical conditions facing financial institutions, both in terms of data availability and in terms of more complex portfolios. This is a question on which future research in this area might focus.

CHRISTOFFERSEN, DIEBOLD, AND SCHUERMANN

The Christoffersen, Diebold, and Schuermann paper addresses another key practical issue in value-at-risk modeling, namely, whether the volatility of important financial market variables such as stock price indices and exchange rates is *forecastable*. By asking whether volatility is forecastable, the paper essentially asks whether there is value to using recently developed econometric techniques—such as some form of GARCH estimation—to try to improve the forecast of the next period's volatility, or whether it makes more sense to view volatility as being fairly constant over the long run. In technical terms, the question concerns whether *conditional* volatility estimates, which place more weight on recent financial market data, outperform *unconditional* volatility estimates, which are based on information from a fairly long historical observation period.

The answer, as the paper makes clear, is that *it depends.* Specifically, it depends on the horizon—or holding period—being examined. The results in the paper indicate that for holding periods of about ten days or more, there is little evidence that volatility is forecastable and, therefore, that more complex estimation techniques are warranted. For shorter horizons, in contrast, the paper concludes that volatility dynamics play an important role in our understanding of financial market behavior.

The basic message of the paper—that the appropriate estimation technique depends on the holding period used in the value-at-risk estimate—implies that there is no simple response to the question, What is the best way to construct value-at-risk models? The answer will clearly vary with the value-at-risk estimates' purpose.

As valuable as the contribution of the Christoffersen et al. paper is, there are some extensions that would link the work even more closely to the real world issues that supervisors and risk managers are likely to face. In particular, the analysis is based on examinations of the behavior of individual financial time series, such as equity price indices, exchange rates, and U.S. Treasury bond returns. Essentially, the analysis considers each individual financial variable as a very simple portfolio consisting of just one instrument. An interesting extension would be to see how or whether the conclusions of the analysis would change if more complex portfolios were considered. That is, would the conclusions be altered if the volatility of portfolios of multiple instruments were considered?

The results already suggest that the ability to forecast volatility is somewhat dependent on the financial variable in question—for instance, Treasury bond returns appear to have forecastable volatility for holding periods as long as twenty days, compared with about ten days for some of the other variables tested. It would be interesting, then, to build on this observation by constructing portfolios comprised of a mixture of instruments that more closely mirror the portfolio compositions that financial institutions are likely to have in practice. Such an experiment presumes, of course, that the risk manager is interested in knowing whether the volatility of the *portfolio* can be forecast, as opposed to the volatility of individual financial variables. In practice, risk managers and supervisors may be interested in knowing the answer to both questions.

LOPEZ

Finally, the paper by my colleague Jose Lopez addresses another important area in the world of value at risk: model validation. The paper explores the question, How can we assess the accuracy and performance of a value-at-risk model? To answer this question, it is first necessary to define what we mean by "accuracy." As the paper points out, there are several potential definitions. First, by accuracy, we could mean, how well does the model measure a particular percentile of the profit-and-loss distribution? This is the definition that has been incorporated into the market risk capital requirements through the so-called backtesting process. As the paper points out, approaches to assessing model accuracy along this dimension have received considerable attention from both practitioners and researchers, and the properties of the associated statistical tests have been explored in several studies.

However, the main contribution of the Lopez paper is its suggestion that alternative approaches to evaluating the performance of value-at-risk models are possible. For instance, another potential approach involves specifying a characteristic of value-at-risk models that a risk manager or a supervisor may be particularly concerned about—say, the model's ability to forecast the size of very large losses—and designing a method of evaluating the model's performance according to this criterion. Such approaches are not formal hypothesis tests, but instead involve specifying what is known as a "loss function," which captures the particular concerns of a risk manager, supervisor, or other interested party. In essence, a loss function is a shorthand method of calculating a numerical score for the performance of a value-at-risk model.

The results in the Lopez paper indicate that this loss function approach can be a useful complement to more traditional hypothesis-testing approaches. I will not go over the detail of his analysis, but the loss function approach appears to be able to provide additional information that could allow observers to separate accurate and inaccurate value-at-risk models. The important conclusion here is *not* that the loss function approach is superior to more traditional hypothesis-testing methods or that it should be used in place of these methods. Instead, the appropriate conclusion, which is spelled out in the paper, is that the loss function approach is a potentially useful supplement to these more formal statistical methods.

A further implication of the analysis is that the assessment of model performance can vary depending on who is doing the assessing and what issues or characteristics are of particular concern to the assessor. Each interested party could assess model performance using a different loss function, and the judgments made by these different parties could vary accordingly.

Before moving on to my concluding remarks, I would like to discuss briefly the material in the last section of the Lopez paper. This last section proposes a method for implementing the loss function approach under somewhat more realistic conditions than those assumed in the first section of the paper. Specifically, the last section proposes a method for calibrating the loss function in the entirely realistic case in which the "true" underlying distribution of profits and losses is unknown. Using a simulation technique, the paper demonstrates how such an approach could be used in practice, and offers some illustrations of the type of information about model accuracy that the approach could provide.

The material in this last section is a promising beginning, but before the actual usefulness of this application of the loss function approach can be assessed, it seems necessary to go beyond the relatively stylized simulation framework presented in the paper. The ideal case would be to use actual profit-and-loss data from a real financial institution's portfolio to rerun the experiments presented in the paper. Admittedly, such data are unlikely to be readily available outside financial institutions, which makes such testing difficult. However, the issue of whether the proposed loss function approach actually provides useful additional information about model performance is probably best assessed using real examples of the type of portfolio data that would be encountered if the method was actually implemented.

Concluding Remarks

In making a few brief concluding remarks about the lessons that can be drawn from these three papers, I would like to point out two themes that I see running through the papers' results. First, as discussed above, the papers highlight the point that in the world of value-at-risk modeling, there is no single correct way of doing things. The papers illustrate that the "right approach" often depends on the question that is being asked and the circumstances influencing the concerns of the questioner. The most important contribution of these papers is their helping us to understand what the "right answer" might be in certain situations, whether that situation is the presence of a fat-tailed distribution or different holding period horizons. Furthermore, the papers illustrate that in some situations, multiple approaches may be required to get a full picture of the behavior of a given portfolio or the performance of a particular model. In both senses, the three papers in this session have helped to provide concrete guidance on how to make such choices as circumstances vary.

The second theme that I see emerging from these papers is a little less direct than the issues I have just discussed. In my view, the papers reinforce the point that value-at-risk modeling—indeed probably most types of risk modeling—is a dynamic process, with important innovations and insights occurring along the way. It has been several years since I myself first started working on value-at-risk issues, as part of the original team that developed the internal models approach to market risk capital charges. Even at that stage, many financial institutions had already devoted considerable time and resources—over periods spanning several years—to the development of the models they were using for internal risk management. Despite this long history, these papers clearly indicate that serious thinking about value at risk is still very much a live issue, with innovations and new insights continuing to come about.

For that reason, no value-at-risk model can probably ever be considered complete or final; it is always a matter of keeping an eye on the most recent developments and incorporating them where appropriate. This is probably a pretty obvious observation to those of you who are involved in risk modeling on a hands-on basis. Nonetheless, it is an important observation to keep in mind as new studies emerge illustrating new shortcomings of old approaches and new approaches to old problems. These studies—such as the three presented here today—do not reflect the failure of past modeling efforts, but instead demonstrate the importance of independent academic research into the practical questions facing risk managers, supervisors, and others interested in risk modeling.

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Session 4

Incentive-Compatible Regulation: Views on the Precommitment Approach

Papers by

Jill Considine

Arupratan Daripa and Simone Varotto

Shuji Kobayakawa

Commentary by

Patrick Parkinson

Pilot Exercise—Pre-Commitment Approach to Market Risk

Jill Considine

An international group of ten banking organizations (the "Participating Institutions") participated in a pilot (the "Pilot") of the pre-commitment approach to capital requirements for market risks (the "Pre-Commitment Approach"). The Pre-Commitment Approach was described in the request for comments published by the Board of Governors of the Federal Reserve System (the "Federal Reserve Board") in 60 Fed. Reg. 38142 (July 25, 1995). In brief, under the Pre-Commitment Approach, banks would specify the amount of capital they wished to allocate to cover market risk exposures over a given period, subject to penalties if trading losses over that period exceeded this precommitted amount.

The Pilot was organized by The New York Clearing House Association (the "Clearing House"). The Participating Institutions were BankAmerica Corporation, Bankers Trust New York Corporation, the Chase Manhattan Corporation, Citicorp, First Chicago NBD Corporation, First Union Corporation, the Fuji Bank Limited, J.P. Morgan & Co. Incorporated, NationsBank Corporation, and Swiss Bank Corporation. This is their report on the Pilot.

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Summary

Set forth below in Part I is a discussion of the background of the Pilot; in Part II, conclusions arising out of the conduct of the Pilot; and in Part III, the Participating Institutions' views as to the next steps. The Pilot left the Participating Institutions with three core conclusions:

- that the Pre-Commitment Approach is a viable alternative to the internal models approach for establishing the capital adequacy of a trading business for regulatory purposes. When properly structured and refined, it should be implemented *as an alternative, and not an "add-on," to existing capital standards*;
- that, for progress to be made, it is essential that the bank regulatory agencies participate actively with the banking industry in the effort to refine how the Pre-Commitment Approach would be implemented in practice; and
- that the most important remaining question requiring an answer is what penalty would result for an institution that incurs losses in its trading business exceeding its pre-committed amount for a relevant period.

I. Background

The complexity and diversity of activities conducted by banking organizations and other financial institutions have developed at a rapid pace in recent years. It has become increasingly apparent to the Participating Institutions, and increasingly recognized by bank regulators as well, that a standardized "one-size-fits-all" regulatory approach, whether as to capital or other matters, is becoming less and less appropriate. With regard to bank capital standards for market risks, the Basle supervisors recognized this view in 1995 by developing the internal models approach as an alternative to the standardized model issued two years earlier. The Pre-Commitment Approach builds upon the logic of the internal models approach by having each banking organization develop its capital requirements in relation to the organization's own activities. By relying on economic incentives instead of on fixed rules, the Pre-Commitment Approach stands at the opposite end of the spectrum from the one-size-fits-all approach.

In a comment letter to the Federal Reserve Board dated October 31, 1995, the member banks of the Clearing House suggested that the Federal Reserve Board and other regulators consider adoption of the Pre-Commitment Approach for two reasons. First, the Pre-Commitment Approach might constitute a way to establish effectively a relationship between an institution's calculation of value at risk for management purposes and prudent capital requirements for regulatory purposes. Second, the Pre-Commitment Approach by its nature results in capital requirements for market risks tailored to the particular circumstances of each institution; it thereby solves the one-size-fits-all problem of the standardized model in the Basle capital standards while avoiding the inaccuracies created by the rigid, uniform quantitative standards imposed by the internal models approach. The letter also suggested that one or more institutions apply the Pre-Commitment Approach on a trial basis; the suggestion was the genesis of the Pilot described in this report.

The purpose of the Pilot was to provide further information and experience to the Federal Reserve Board, the Federal Deposit Insurance Corporation ("FDIC"), and the Office of the Comptroller of the Currency (the "OCC")—collectively, the "U.S. Agencies"—as well as to the Ministry of Finance, the Bank of Japan in Japan, and the Federal Banking Commission in Switzerland—together with the U.S. Agencies, the "Agencies"—as well as to the Participating Institutions themselves, as to the usefulness and viability of the Pre-Commitment Approach for regulatory purposes as applied to the Participating Institutions' trading portfolios and activities. In addition, the appropriate relationship between (i) "value at risk" and other measurements of risk, on the one hand, and (ii) the appropriate regulatory capital level, on the other, is unique to each institution and its circumstances. It was hoped that the Pilot would generate practical experience concerning that relationship for the Participating Institutions.

The Pilot was conducted under the assumption that, in practice, the Pre-Commitment Approach would be a substitute for other market risk capital standards, and not an additional capital measurement or requirement to be added to other capital standards or requirements. In addition, the Clearing House, as well as several of the Participating Institutions individually, are on record as believing that the appropriate penalty for exceeding pre-committed capital levels is disclosure by the affected institution that a loss exceeding its pre-committed capital amount for the relevant period has occurred. The Participating Institutions conducted the Pilot under the assumption that the penalty would be disclosure.

Prior to commencing the Pilot, the Participating Institutions held several meetings with the U.S. Agencies to discuss the upcoming Pilot, how it should be conducted, and what it might accomplish. The non-U.S. Participating Institutions met with the relevant Agencies in their countries as well. Following these meetings, the Participating Institutions agreed upon the purpose, scope, and mechanics of the Pilot.

In particular, the Participating Institutions agreed that the Pilot would be conducted for four quarterly measurement periods ("Measurement Periods") corresponding to calendar quarters as well as to customary reporting periods for both call report purposes and reporting under the Securities Exchange Act of 1934. The Measurement Periods were (i) October 1, 1996, through December 31, 1996; (ii) January 1, 1997, through March 31, 1997; (iii) April 1, 1997, through June 30, 1997; and (iv) July 1, 1997, through September 30, 1997.

The Pilot was conducted by the Participating Institutions on a consolidated basis. Accordingly, pre-committed capital amounts and related P&L Changes (as defined below) were identified for, and took into account, the consolidated trading operation, including activities in bank subsidiaries as well as Section 20 subsidiaries.

Prior to the commencement of each Measurement Period, (i) each Participating U.S. Institution will identify in writing to the Board and to the Agency that is the primary regulator for its lead bank subsidiary (together, its "Primary Regulators"), as well as to the Clearing House, its pre-committed capital amount for the upcoming Measurement Period; and (ii) each non-U.S. Participating Institution will identify to the Agency that is its primary regulator (its "Primary Regulator"), as well as to the Clearing House, its pre-committed capital amount for the upcoming Measurement Period. That amount was eventually compared with the change in the relevant Participating Institution's trading profits and losses (the "P&L Change") for the relevant Measurement Period based upon all of such Participating Institution's consolidated trading activities (both proprietary and for its customers), not just its proprietary account. Accordingly, the P&L Change took into account, in addition to net gains or losses from proprietary trading, (i) brokerage fees, (ii) dealer spreads, (iii) net interest income before taxes associated with trading positions, and (iv) the net change between the beginning and end of the Measurement Period in the Participating Institution's reserves maintained against its trading activities.

The pre-committed capital amount identified by a Participating Institution for a Measurement Period covered both general market risk and specific risk arising out of such Participating Institution's trading portfolios and activities for the relevant period.[1] This approach is consistent with defining the P&L Change with which a pre-committed capital amount is compared as the change in the relevant Participating Institution's trading profits and losses for the relevant Measurement Period from all sources and risks.

Each Participating Institution delivered to the Agency that is its primary regulator an "Individual Institution Report" for each Measurement Period. These Individual Institution Reports contained both pre-committed capital amounts and P&L Changes for each Measurement Period. Thus, the reports made possible a simple comparison of the pre-committed capital amount for each Measurement Period with, if applicable, the negative cumulative P&L Change calculated as of the end of such Measurement Period. Each Participating Institution reported its P&L Change for each Measurement Period irrespective of whether the P&L Change was positive (a profit) or negative (a loss).[2]

The Clearing House also prepared and distributed to all of the Agencies and to the Participating Institutions an "Aggregate Data Report." The Aggregate Data Report is cumulative (see table). It shows, for each Participating Institution (identified by number instead of name for confidentiality reasons) and Measurement Period, the ratio of such Participating Institution's P&L Change to its pre-committed capital amount for the relevant Measurement Period.

PRE-COMMITMENT PILOT EXERCISE: AGGREGATE DATA REPORT

Bank	Fourth-Quarter 1996 P&L:PCA Ratio	First-Quarter 1997 P&L:PCA Ratio	Second-Quarter 1997 P&L:PCA Ratio	Third-Quarter 1997 P&L:PCA Ratio
1	0.56	1.21	1.39	1.09
2	2.27	1.20	2.18	0.96
3	3.56	3.79	3.25	3.61
4	0.44	0.59	0.74	0.84
5	1.84	2.92	1.89	1.81
6	0.42	0.68	0.75	0.54
7	0.81	1.01	1.12	1.12
8	0.77	0.42	1.15	0.91
9	5.43	5.89	5.11	6.60
10	1.46	1.99	1.36	1.88

Notes: P&L is trading profit and loss on consolidated trading activities for the Measurement Period. PCA is the pre-committed capital amount for market risk for the Measurement Period.

II. Conclusions from the Pilot

The Participating Institutions drew the following conclusions from the Pilot of the Pre-Commitment Approach:

1. In the view of the Participating Institutions, steps should be taken to implement the Pre-Commitment Approach, when properly structured and refined, as a replacement for existing market risk capital requirements. The Pilot demonstrated that the Pre-Commitment Approach is a viable alternative to the internal models approach for establishing the capital adequacy of a trading business for regulatory purposes. The Participating Institutions believe that the Pilot demonstrated that the Pre-Commitment Approach provides strong incentives for prudent risk management and more efficient allocation of capital as compared with other existing capital standards. The Participating Institutions were able to establish and report in a timely manner pre-committed capital amounts and P&L Changes for the relevant Measurement Periods.
2. The Pilot in effect assigned to the Participating Institutions the responsibility for determining an appropriate level of capital, free of any regulatory preconceptions as to what that specific level should be. As a result of having to focus on an appropriate amount of capital, the Pilot contributed to the development and depth of the Participating Institutions' thinking as to the purpose of capital and the distinction between the economic capital maintained for the benefit of shareholders to accommodate the variability of revenue and income and the regulatory capital available to protect the safety and soundness of the financial system from the effects of unanticipated losses.
3. At the outset of the Pilot, it was anticipated that the Aggregate Data Report would include the ratio of the pre-committed capital amount to the market risk capital requirement for each Participating Institution in each Measurement Period. This turned out not to be feasible because the Participating Institutions became certified to use the internal models approach for market risk capital requirements at different times. Nevertheless, each Participating Institution has, on an informal basis, compared its pre-committed capital amount with its estimated market risk capital requirement under the internal models approach; generally, pre-committed capital amounts were significantly less than the market risk capital requirements estimated to apply under the market risk provisions. The Participating Institutions believe that the results of the Pilot suggest that the "3X" multiplier, as well as the specific risk component, even after the Basle Committee's revision dated September 17, 1997, lead to excessive regulatory capital requirements for their trading positions.
4. As reflected in the Aggregate Data Report, no Participating Institution reported a negative P&L Change exceeding its pre-committed capital amount. The Participating Institutions recognize that the Pilot was conducted during a period of moderate market volatility and generally favorable trading results reported by financial institutions. Nonetheless, the pre-committed capital amounts were calculated to cover losses stemming from unusual spikes in volatility and market reversals, and the Participating Institutions would not change the procedures, methods, and vetting processes applied during the Pilot in light of the unsettled markets in October 1997 following the conclusion of the Pilot.
5. The ratios of P&L Changes to pre-committed capital amounts varied significantly. For example, the ratios reported by Participating Institution no. 9 were generally five times that of Participating Institution no. 4. The Participating Institutions are not uncomfortable with the differences. Such differences arise from differences among the institutions in the nature of their trading books, the varying risk appetites and risk management techniques among firms, differing ratios of proprietary trading revenues to customer flow revenues among firms, and differing views as to the relationship between economic and regulatory capital. It would be of interest to know whether the Agencies, which have access to the full spectrum of the data underlying the Aggregate Data Report, have additional insights as to the sources of differences among the Participating Institutions, which did not share their own underlying data with each other.

III. Looking Forward

The Participating Institutions believe that the Pre-Commitment Approach is a viable alternative to the internal models approach for determining the capital adequacy of a trading business, and that steps should be taken to refine and ultimately implement the Pre-Commitment Approach. Before further effort by the banking industry can be justified or progress made, it is essential that the Agencies participate actively in the effort to refine how the Pre-Commitment Approach will be implemented in practice.

Assuming the Agencies concur with the Participating Institutions' views, implementation of the Pre-Commitment Approach requires that the Agencies confirm what penalties would apply if a banking institution violates the criteria for capital adequacy specified in the Pre-Commitment Approach. The Participating Institutions believe that disclosure is the appropriate penalty, and they conducted the Pilot under the assumption that disclosure would indeed be the penalty. It would be useful to discuss with the Agencies whether they concur with this view, and how they believe such disclosure might occur.

Finally, although the Pre-Commitment Approach was initially proposed (and the Pilot was conducted) for the market risk of trading businesses, the Participating Institutions believe that the benefits of the Approach are likely to exist when applied to other risks of trading businesses. The Pre-Commitment Approach goes directly to the basic question of whether a business possesses adequate capital to absorb unanticipated losses. The pre-committed capital as applied to a business covers any risk—market, specific, operational, legal, settlement—that has the potential to create a loss. As a result, the Pre-Commitment Approach avoids many of the complications and inefficiencies generated when capital charges are set separately for each category of risk. Furthermore, institutions differ in how they measure and manage the component risks, and the correlations between the risks likely will vary according to each institution's business mix. The Pre-Commitment Approach recognizes these differences while providing incentives to ensure that minimum prudential standards are maintained within the industry.

ENDNOTES

1. A Participating Institution's pre-committed capital amount for a Measurement Period did not cover, however, foreign exchange and commodities positions outside the trading account (activities that are covered in the market risk rule that was recently adopted).

2. If the Pre-Commitment Approach is implemented, only a negative cumulative P&L Change for a Measurement Period having an absolute value exceeding the relevant Participating Institution's pre-committed capital amount for such Measurement Period would give rise to a disclosure requirement or other penalty.

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Value at Risk and Precommitment: Approaches to Market Risk Regulation

Arupratan Daripa and Simone Varotto

1. Introduction

Traditionally, regulation of banks has focused on the risk entailed in bank loans. Loans are typically nontraded assets. In recent years, another component of bank assets has become increasingly important: assets actively traded in the financial markets.[1] These assets form the "trading book" of a bank, in contrast to the "banking book," which includes the nontraded assets such as loans. Though for most large banks the trading book is still relatively small compared with the banking book, its rising importance makes the market risk of banks an important regulatory concern.

In January 1996, the European Union (EU) adopted rules to regulate the market risk exposure of banks, setting risk-based capital requirements for the trading books of banks and securities houses. At this point, one must ask what the purpose of such regulatory capital is. We proceed under the hypothesis that the purpose of regulatory capital is to provide a buffer for contingencies involving large losses, in order to protect both depositors and the system as a whole by reducing the likelihood that the system will fail. In this paper, we look at two different ways of calculating bank capital for market risk exposures and compare their performance in delivering an adequate cover for large losses.

The approach taken by the EU is to use a "hard-link" regime that sets a relation between exposure and capital requirement exogenously. The adopted requirements, known as the standardised approach, laid down rules for calculating the capital requirement for each separate risk category (that is, U.K. equities, U.S. equities, U.K. interest rate risk, and so on). These are added together to give the overall requirement. A weakness of this method is that it does not take into account the diversification benefits of holding different risks in the same portfolio, and thus yields an excessive capital requirement for a large diversified player. One way to correct for this problem is to use the value-at-risk (VaR) models that some banks have developed to measure overall portfolio risk. The Basle Supervisors' Committee has now agreed to offer an alternative regime, with capital requirements based on such internal VaR models, and the EU is considering whether to follow suit.

While the measure of risk exposure employed by the two regimes is different, in both approaches the regulator lays down the parameters for the calculation of the capital requirement for a given exposure. Thus, both regimes embody a hard link.

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Under VaR, the capital requirement for a particular portfolio is calculated using the internal risk management models of the banks.[2] For any portfolio, the aim is to estimate a level of potential loss over a particular time period that would only be exceeded with a given probability. Both the probability and the period are laid down by the regulator. Basle has set these at 1 percent and ten days, respectively. The capital requirement is based on this potential loss.[3]

But using VaR comes at a price. The regulator must try to ensure that the internal model used to calculate risk is accurate. Otherwise, banks might misrepresent their risk exposure. However, back-testing to check the accuracy of an internal VaR model is difficult in the sense that a large number of observations are needed before an accurate judgment can be made about the model.[4] This motivated economists Kupiec and O'Brien (1997) of the Federal Reserve Board to put forward a new "precommitment" approach (PCA) that proposes the use of a "soft link." Such a link is not externally imposed, but arises endogenously. In the case of the proposed precommitment approach, the link between exposures held and the capital backing them is induced by the threat of penalties whenever trading losses exceed a level prespecified by the bank (known as the precommitment capital).

Specifically, under PCA, banks are asked to choose a level of capital to back their trading books for a given period of time (for example, one quarter). If the cumulative losses of the trading book exceed the chosen cover at any time during the period, the banks are penalised, possibly by fines. The chosen capital is thus a "precommitment" level, beyond which penalties are imposed. The task of the regulator is to choose an appropriate schedule of penalties to induce a desirable choice of cover for each level of risk. The banks then position themselves in terms of risk and capital choices for the trading book. The idea is attractive because it does not require the regulator to estimate the level of trading book risk of any particular bank or to approve the firm's model, and it promotes a more "hands-off" regulation.

2. Agency Problems and Fraud

This paper examines whether principal agent problems between the shareholders and the managers in banks would undermine the use of a capital regime relying on incentives for the shareholders.[5] In particular, it looks at whether the management might choose to run positions that were excessive relative to the capital of the bank. This is not a question of illicit activity such as the hiding of positions, which no capital regime will deal with, but whether the managers, because of concerns about market share, their own bonuses, etc., might on occasions take excessive risk. For example, a very large position might be taken on the assumption that it could be treaded out of in minutes. Hard-link regimes avoid this issue because the positions taken at any time must be consistent with the amount of capital available to back them according to a formula laid down by the regulators. There is no scope for judgment by the managers. The scope for such judgment is an advantage in PCA. Depending on the effectiveness of the incentives, however, it could also be a weakness.

3. Hard Links and Soft Links: A Potential Trade-Off

PCA not only circumvents the problems of back-testing, but also gives the banks much greater freedom in choosing the portfolios they wish to carry. Since the trading desks of banks are likely to be more adept at estimating risks of various trades, it seems inefficient to impose hard links.

While these advantages of PCA have been discussed in the literature, another aspect of this soft-link approach seems to have received little attention. The flexibility of a soft-link approach such as PCA comes from the fact that it is not directly prescriptive, but creates incentives through the use of penalties. In more general terms, PCA tries to solve what is known as a "mechanism design" problem. It attempts to specify a mechanism (in this case, a penalty framework that the banks take into account in choosing portfolio risk and committed capital) that would make it incentive-compatible for the banks to choose the socially desirable risk profile. The success of such a programme depends on how well the regulator anticipates the strategic opportunities that a mechanism might create.

In other words, while soft-link approaches are flexible and not subject to measurement problems, they create a host of strategic issues. To build a successful soft-link regulatory policy, one must recognise all possible conflicts of interest that might arise subsequently, and provide incentives to align them with the objectives of the regulator.

The first step toward building an optimal soft-link policy is to analyse the incentive effects of PCA in a detailed model of the conflicts of interest within the bank. An example of such a model can be found in Daripa and Varotto (1998a).

In Daripa and Varotto, we find that switching to PCA from a hard-link approach does entail a trade-off. On the one hand, the switch would allow firms greater scope to choose portfolios that were appropriate given their expertise and market liquidity. On the other hand, the switch could also increase the likelihood that large players have insufficient capital to cover market spikes. One issue is whether key features of the soft-link approach could be combined with certain features of a hard-link approach in order to circumvent certain incentive problems.

4. Separation of Ownership and Control in Large Banks: The Agency Problem

A large part of the corporate finance literature explores the corporate control problem. The problem is empirically well documented and theoretically well understood. The typical solution to agency problems is to use incentive contracts (see, for example, Gibbons and Murphy [1992], Jensen and Murphy [1990], Garen [1994], and the survey by Jensen and Warner [1988]). A corporate control problem arises whenever ownership is separate from the decision-making body. In many large corporations, ownership is diffuse and decisions are taken by managers.

As in most large corporations, an integral feature of large modern banks is the separation of owners from day-to-day decision making. The ownership is diffuse—there are numerous small shareholders who have little impact on most decisions. For example, in the United Kingdom, shareholders rarely have more than 2 to 3 percent of the shares in any one bank. Even relatively large shareholders would in general have hardly any impact on day-to-day risk taking. It is the incentives of, say, the traders of the bank that determine what specific strategies they might adopt on a particular day. Thus, it is important to see to what extent the owners can control their actions.

However, in regulating banks, scarce attention has been paid so far to such internal control problems and their effect on the success of the regulatory mechanism. There is a good reason for this lack of attention. Regulation usually takes the form of an exogenous specification for capital for each level of estimated risk carried by the bank (combined with some form of inspection to ensure that the rules were adhered to). As Daripa and Varotto (1998a) show, regulation by such a hard link is not sensitive to agency problems.[6] But this is no longer true when we consider a soft-link approach. In Kupiec and O'Brien (1997), the regulator interacts with banks intended as homogenous entities. Shareholders and managers are not considered as separate centres of interest. This leaves aside the important issue of the effects of the incentive structure within the bank. Indeed, under PCA, the generation of the right incentives is at the very heart of the problem. Thus agency-related control problems become central issues and must be addressed in order to gain a clear understanding of the regulatory incentives that would be generated.

As a control device, the owners write contracts with managers, and then the managers make the most of the trading decisions. Moreover, managers cannot usually be fined (that is, paid negative salaries) in the event of a loss.[7] Thus, decisions about trading-book risk are taken by managers with limited liability, while the owners have to suffer the losses in the trading book and pay the penalty in the case of a breach under PCA.

This fact implies that to study the effectiveness of the incentive structure generated by PCA, it is no longer sufficient to consider the bank as a single entity whose actions are influenced directly by the regulatory incentives. Without explicitly modeling the agency structure and the nature of optimal incentive contracts in the bank, the effect of regulatory policies on large banks is difficult to gauge.

In other words, to evaluate a soft-link regulatory scheme, the appropriate question to ask relates to the effect of the regime on the incentive structure within the bank. An analysis of this question would tell us which regulatory objectives are filtered through, and what aspects of the regulatory mechanism need further modification. In this paper, we aim to provide such an analysis.

5. Summary of the Results

In Daripa and Varotto (1998a), we investigate the above issues in a simple principal-agent framework. We obtain the following results.

5.1 Agency Incentives under a Hard-Link Approach

First, we show that conflicts of interest within the bank[8] have no implications for hard-link policies. The regulator sets a capital requirement for each level of estimated risk. At any point in time, the risk cannot exceed the level consistent with the given capital. It is easy to see that this is true irrespective of the incentive structure in the bank. Clearly, when regulators are relying on models specified by the firms to generate capital requirements there may be some scope for managers to produce results that downplay the losses. But the managers' scope is severely limited. The regulators lay down the amount of returns data that must be used (one year minimum), the parameters used in the model, and approve the model. The regulators also carry out back-testing.

So, while a hard-link regime such as VaR is subject to measurement problems—as highlighted in the literature—and is economically unattractive in some respects, the presence of a hard link does manage to sort out some potential strategic complications. A hard link works because it sets an exogenous requirement that cannot be breached.

However, the estimated risk under VaR uses fixed parameters and does not take into account extra information about, say, future market liquidity that might be available to the manager. The estimated risk also fails to reflect managerial expertise in choosing holding periods optimally, given the opportunity set. Thus, the VaR estimate may often be an overestimate. Of course, an overestimate provides even better cover for extreme losses; at the same time, however, it cuts off certain investment opportunities inefficiently.

5.2 Agency Incentives under PCA

While the structure of an agency would be a concern under any soft-link regime, the precise effects would differ across different soft-link policies. In this paper, we analyse the effects of agency on the outcomes generated by PCA.

Under PCA, the capital chosen does not constrain the manager's choice of riskiness. Even if the shareholders used an internal model to monitor risk, they would not want to cut off too many investment opportunities. In fact, they would like to rely on the judgments of the manager in order to reap the benefits of his expertise. Instead of putting a priori constraints on portfolios, they would want to link payment to "performance."

In the absence of a priori restrictions on the choice of risk, the outcome depends on the manager's preferences, because even with the use of a VaR model the manager could choose the holding period according to expected market liquidity or price volatility. We show that if managers care only about monetary compensation, the principal (that is, the bank owner/shareholders) could design contracts that would generate incentives for the manager to behave consistently with the principal's objectives, and in turn, the regulator could therefore achieve the right capital levels. But the manager might also be interested in nonmonetary rewards (for example, attaining star status by generating large positive returns) and might therefore undertake high-risk strategies (limited managerial liability implies that only the upside matters). In Daripa and Varotto (1998a), we show that in this case tighter controls on the manager can be achieved only at the cost of the principal's own profit. This leads the principal to choose a level of control that is not too tight, resulting in a nontrivial probability of very risky investments and large losses in relation to the amount of capital precommitted.

6. Modifying PCA: Optimal Regulation

Correcting for agency distortions is, in general, not straightforward. This is a problem of designing a mechanism to implement a certain objective given that various interacting agents have conflicting preferences.[9] Such a general approach could be very fruitful in this context. While devising a suitable approach is one of our research areas, an analysis along this line is beyond the scope of the paper.

However, there is another possible route—since the interaction between the regulator and the banks takes place repeatedly over time, we need not focus simply on static regulation. The key problem here is that on the one hand, maintaining flexibility makes it necessary to allow the banks to choose their own riskiness. On the other hand, such flexibility might result in loss of control by the principal over the manager. A hard link is inflexible, but it allows full control.

A loss of control occurs when managers of different types have different preferences for portfolio risk. In view of this, we might attempt to retain the flexibility and yet harden the soft links under PCA in the following manner.

Consider the following scheme for any given bank:

- Regulate according to PCA to start with.
- In any future period t, if there has been no breach in period t-1, regulate according to PCA.
- If a breach occurred in period t-1, adopt a hard-link approach for T periods (if VaR is econometrically problematic, adopting the standardised approach would do just as well—as would any other hard-link regime that puts limits on managerial risk taking). At the end of T periods, switch back to PCA.

Such a scheme would help eliminate the agency distortion. The reason is that the manager must trade off risk today with risk tomorrow.[10]

Suppose the manager puts a large weight on portfolio risk. Suppose he takes a very high-risk strategy in period t and large losses occur. In a static context, limited liability implies that the manager would not care about the losses. But now there are other consequences. Since the manager puts a large weight on risk, unless he discounts the future heavily, he would care about the risk he can undertake in period t+1 and after. Higher risk in period t increases the chances of facing a hard-link regime for T periods that would put limits on managerial risk taking. Thus, there is now a trade-off. This helps reduce the agency distortion.

The policy is simple enough—a violating bank must go through a "probationary" phase during which its risks would be very inflexibly controlled. This approach maintains the flexibility of PCA, while hardening the links on punishment paths.

In future research, we hope to explore these issues further and shed light on optimal regulation.

ENDNOTES

The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of England. The content of the paper as well as the exposition have benefited enormously from regular interaction with Patricia Jackson and Ian Michael. We have also benefited from comments on an earlier version by William Perraudin and two referees for the Bank of England Working Paper series, as well as comments by our discussants Jean-Charles Rochet and Paul Kupiec at the Financial Regulation and Incentive Conference at the Bank of England. We are grateful to all of them.

1. For example, securities and foreign exchange or commodities positions that are held for short-term trading purposes.

2. The value at risk of a given portfolio can be calculated via parametric or nonparametric (historical-simulation) models. Parametric approaches are based on the assumption that the distribution of future returns belongs to a given parametric class. The historical-simulation approach produces a time series of profits and losses that would have occurred if the portfolio had been held over a specified estimation period.

3. The Basle rules specify an additional multiplier of three, which is applied to the results of the VaR model to convert it into a capital requirement.

4. See Kupiec (1995) and Jackson and Perraudin (1996).

5. This paper is a summary of the results derived by Daripa and Varotto (1998a). Readers interested in a more formal discussion should refer to that paper.

6. With this we do not mean that hard-link regulation prevents managers from undertaking fraudulent activities. An implicit assumption in our analysis is that managers act legally.

7. Even when fired, most managers are usually able to find other jobs.

8. Clearly, if they do not degenerate into fraudulent actions on the part of the manager.

9. For a lucid discussion of the central issues in the implementation literature, see the survey by Moore (1992).

10. Of course, such a scheme would work only if the expected duration of the manager's employment were not very short.

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Designing Incentive-Compatible Regulation in Banking: The Role of Penalty in the Precommitment Approach

Shuji Kobayakawa

1. Introduction

The purpose of this paper is to present a framework for incentive-compatible regulation that would enable regulators to ensure that riskier banks maintain higher capital holdings.

Under the precommitment approach, a bank announces the appropriate level of capital that covers the maximum value of expected loss that might arise in its trading account. If the actual loss (after a certain period) exceeds the announced value, the bank is penalised. This framework creates the correct incentive for banks: The banks choose the level of capital that minimises the total cost, which consists of the expected cost of penalty and the cost of raising capital.

Nevertheless, it is not certain that the regulator will always implement the mechanism through which banks accurately reveal their riskiness. To be more precise, the approach relies solely on the first-order condition of cost minimisation, in which the regulator need only offer a unique penalty rate and let each bank select the amount of capital that satisfies the first-order condition. This implies that the regulator needs no information ex ante with regard to the riskiness of each bank (that is, the regulator can extract private information ex post by observing how much capital each bank chooses to hold after setting the unique penalty rate).

It is, however, questionable whether riskier banks will always choose a higher level of capital. The choice of capital holding depends on the bank's private information, such as the shape of the density function of its investment return. Riskier banks may in fact choose smaller amounts of capital. Thus, the normative capital requirement dictating that riskier banks should hold higher levels of capital may not always be satisfied under the precommitment approach. With this in mind, we examine an alternative to the precommitment approach, in which the regulator is viewed as offering incentive-compatible contracts that consist of both the level of capital and the penalty rate, and see whether banks fulfill the normative capital requirement.

The paper is organised as follows: In the next section, we briefly review the precommitment approach and show that in some cases it may not be possible to determine each bank's riskiness by observing how much capital it decides to hold. In Section 3, we develop a model from the perspective of mechanism design whereby the regulator

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designs a menu of contracts. We then examine under different scenarios whether the regulator could achieve the norm where riskier banks decide to hold higher levels of capital. Section 4 summarises the paper's findings.

2. Outline of the Precommitment Approach

In this section, we briefly review the model set forth by Kupiec and O'Brien (1995), who first proposed the precommitment approach. We will examine the case where monetary fines are used as a penalty and will discuss how the fines work by letting banks hold optimal levels of capital, according to the innate qualities of the assets in their trading accounts.[1]

First, the net return of assets in banks' trading accounts is denoted by Δr, which follows the density function, $dF(\Delta r)$, and banks hold capital equivalent to k. In the model, there are two cost factors—the cost associated with raising capital and the expected cost of the penalty. The penalty is imposed if the actual net loss exceeds the precommitted amount (that is, if the net return is lower than $-k$, then the penalty is imposed). Assuming the penalty is imposed proportional to the excess loss, the total cost function is written as follows:

(1) $$C(k,\rho) = \eta k - \rho\int_{-\infty}^{-k}(\Delta r + k)dF(\Delta r),$$

where η is the marginal cost of capital, and ρ is the penalty rate. The first term represents the cost of raising capital. The second term shows the total expected cost of the penalty. Taking the first derivative with respect to k, we have

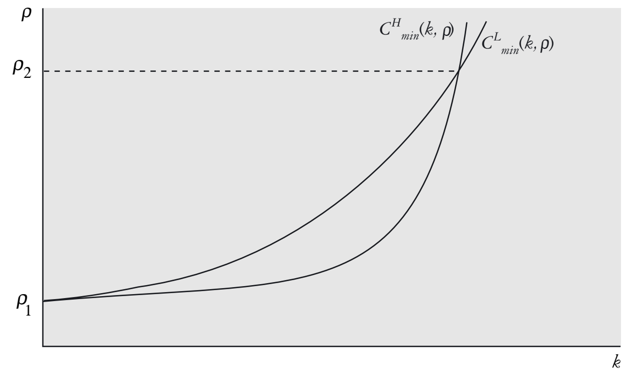
(2) $$\frac{\partial C(k,\rho)}{\partial k} = \eta - \rho F(-k) = 0.$$

Given the rate of penalty, banks choose their optimal levels of capital, which satisfy equation 2.[2]

Although Kupiec and O'Brien do not go beyond this point, let us extend the model in such a way that it incorporates the riskiness of banks.[3] Suppose now that two types of banks exist: banks with riskier assets (H-type banks), whose density function is denoted by $dF^H(\Delta r)$, and banks with less risky assets (L-type banks), whose density function is denoted by $dF^L(\Delta r)$. We assume the variance of $dF^H(\Delta r)$ is larger than that of $dF^L(\Delta r)$. Then, we can imagine one example of the minimum cost curves, for

Chart 1

One Example of Minimum Cost Curves for High-Risk and Low-Risk Banks



H-type and L-type banks, on which the first-order condition is always satisfied (Chart 1).

$C^H_{min}(k,\rho)$ is the minimum cost curve for H-type banks, and $C^L_{min}(k,\rho)$ is the minimum cost curve for L-type banks. The higher the penalty rate offered by the regulator, the higher the capital requirement for banks to satisfy the first-order condition. The figure also generalises the case where H-type banks have a gentle curve when k is low, while they have a steep curve when k is high. This occurs because when k is low (that is, close to the mean of the density function), an additional increase in the penalty rate requires H-type banks to add more capital than L-type banks must add to retain the first-order condition. The magnitude of changes in the density function per one-unit increase in capital level is less for H-type banks (whose variance is larger) than for L-type banks. On the contrary, when k is high (that is, close to the tail of the density function), an additional increase in the penalty rate may require L-type banks to add more capital than H-type banks to reestablish the first-order condition. The reason is that the magnitude of changes in its density function per one-unit increase in capital level is less for L-type banks. The following two situations could arise:

- If the regulator charges a penalty rate higher than ρ_2, then L-type banks choose to hold higher levels of capital.
- If the regulator charges $\rho \in [\rho_1 \rho_2]$, then H-type banks choose to hold higher levels of capital.

A summary of these situations follows.

Kupiec and O'Brien assume that the regulator, without knowing the banks' riskiness, can allow banks to reveal their riskiness by charging a unique penalty rate.[4] Each bank, given the penalty rate, voluntarily chooses the level of capital that minimises the total cost. The authors further claim that the choice of capital level is incentive compatible for every bank. But without knowing where the minimum cost curves lie, the regulator cannot assess banks' riskiness just by observing the levels of capital (that is, high-risk banks sometimes hold more capital, sometimes less). In this situation, we are not sure whether the regulator can overcome private information (that is, the riskiness of each bank) just by penalising at the uniform rate.

Next, we suggest a general model in which the regulator offers contracts that consist of the level of capital and the penalty rate and lets banks select a contract—an arrangement that enables the regulator to assess the riskiness of each bank correctly. We will see how we could satisfy the normative requirement that high-risk banks hold higher levels of capital.

3. The Model

The following model is designed to establish whether the regulator could determine banks' riskiness by offering banks a menu of contracts and letting each select one. We are interested in two points: How incentive compatibility can be satisfied in both the precommitment approach and the model presented below, and whether the normative standard of capital requirements—whereby banks with riskier assets choose to hold higher levels of capital than those with less risky assets—is fulfilled.

3.1. Setup of the Model

Two players participate in the game: the regulator and the banks. The banks are categorised according to the innate qualities of the assets in their trading accounts. For simplicity, we assume there are two types of banks—H-type (a bank whose portfolio consists of high-risk, or large-variance, assets) and L-type (a bank whose portfolio consists of low-risk assets). Although the banks know their own types, the regulator does not know ex ante which bank belongs to which type. One may argue, however, that the regulator can learn each bank's type through monitoring or from the records of on-site supervision. Nevertheless, we assume that most of the assets in the trading accounts are held short term and that banks can form the portfolios with different levels of riskiness. The assessment of the riskiness of a portfolio at the time of on-site supervision may therefore not be valid for a long time. Hence, it is reasonable to assume that the regulator is uninformed about the types. Remember, we are concerned with the quality of the banks' assets in their *trading accounts*. It may not be appropriate to extend the same interpretation to the assets in their banking accounts. Because these assets are held for much longer periods, the information obtained through monitoring is valid longer. The scope for private information is therefore much more limited.

Next, let us explain the sequence of events in the model. In each of the game's three periods, the following events take place.

Period 0

1. Banks collect one unit of deposits, whose rate of interest is normalised to zero. The deposit has to be paid back to depositors at the end of the game (that is, in Period 2).
2. The banks then invest the money in financial assets.

Period 1

1. The regulator offers a menu of contracts consisting of different levels of required capital and penalty rates corresponding to each capital requirement level.
2. Banks choose a contract from the menu. For them, accepting a contract means that they hold $k_i \in (0, 1)(i = H, L)$ as capital.

Period 2

1. The return on investment, $\tilde{r}$, is realised.
2. If the return fails to achieve the precommitted level, the regulator penalises the bank.

Let the return on investment be a stochastic variable in the range of $[r^-, r^+]$, and it follows a density function, $dF(\tilde{r})$. We denote the return on investment by $dF_H(\tilde{r})$ for an H-type bank, and $dF_L(\tilde{r})$ for an L-type bank. We assume that the variance of $dF_H(\tilde{r})$ is larger than that of $dF_L(\tilde{r})$, but we do not assume any specific shape of distribution functions.[5]

The regulator penalises the bank if the net loss from the investment, $-(\tilde{r}-1)$, exceeds the precommitted value k_i; hence the penalty is imposed if $1-k_i \geq \tilde{r}$. Let the penalty rate be denoted by $p_i(i = H,L)$, so that the amount of penalty is $p_i \times [(1-k_i)-\tilde{r}]$.

We analyse the three following cases according to the relative size of the cumulative density:[6]

Case 1: $F_H(1-k_i) \geq F_L(1-k_i)$ for $k_i \in (0,1)$

The cumulative density for H-type banks is always larger than the one for L-type banks.[7]

Case 2: $F_H(1-k_i) \geq F_L(1-k_i)$ for k_i close to 0

$F_H(1-k_i) < F_L(1-k_i)$ for k_i close to 1

The cumulative density for H-type banks is larger when the level of capital is close to 0; it is smaller when the level of capital is close to 1.

Case 3: $F_H(1-k_i) \leq F_L(1-k_i)$ for k_i close to 0

$F_H(1-k_i) > F_L(1-k_i)$ for k_i close to 1

The cumulative density for H-type banks is smaller when the level of capital is close to 0; it is larger when the level of capital is close to 1.[8]

We now write the bank's cost function as follows:

$$C_H^H \equiv \int_{\bar{r}}^{1-k_H} p_H[(1-k_H)-\tilde{r}]dF_H(\tilde{r}) + \eta k_H, \tag{3}$$

where C_j^i represents the cost function of the bank that has an innate riskiness of j but announces the riskiness i. The first term in this cost function is the expected cost of a penalty. The second term is the cost associated with raising capital equivalent to k_H, where η is the marginal cost of capital. Likewise, the cost function of an L-type bank is as follows:

$$C_L^L \equiv \int_{\bar{r}}^{1-k_L} p_L[(1-k_L)-\tilde{r}]dF_L(\tilde{r}) + \eta k_L. \tag{4}$$

3.2. Regulator's Programme

Let us now analyse how the regulator designs the mechanism in which the H-type and L-type banks reveal their types truthfully. The following programme is a starting point:[9]

$$\min_{\begin{Bmatrix} k_L, k_H \\ p_L, p_H \end{Bmatrix}} L = \delta \times \left[d\left[k_L - \left(1 - F_L^{-1}\left(\frac{\eta}{P_L}\right)\right)\right]^2 + \left[k_H - \left(1 - F_H^{-1}\left(\frac{\eta}{P_H}\right)\right)\right]^2\right]$$
$$+ (1-\delta) \times max(0, k_L - k_H), \text{ where } k_L \neq k_H$$

$$(\mathrm{IC_H})\quad C_H^H = \int_{\bar{r}}^{1-k_H} p_H[(1-k_H)-\tilde{r}]dF_H(\tilde{r}) + \eta k_H$$
$$\leq \int_{\bar{r}}^{1-k_L} p_L[(1-k_L)-\tilde{r}]dF_H(\tilde{r}) + \eta k_L \equiv C_H^L$$

$$(\mathrm{IC_L})\quad C_L^L = \int_{\bar{r}}^{1-k_L} p_L[(1-k_L)-\tilde{r}]dF_L(\tilde{r}) + \eta k_L$$
$$\leq \int_{\bar{r}}^{1-k_H} p_H[(1-k_H)-\tilde{r}]dF_L(\tilde{r}) + \eta k_H \equiv C_L^H.$$

The loss function of the regulator consists of both the deviation of capital from the level specified by the first-order condition and the difference between capital holdings of banks with different risk levels. The term in parentheses after δ represents any capital holding that is not equivalent to the optimal level. Such a case is regarded as costly for the regulator. This applies to both L-type and H-type banks. The term after $(1-\delta)$ shows that the regulator is willing to let high-risk banks hold more capital. As long as high-risk banks hold more capital, the regulator does not incur any loss. This is consistent with the norm specifying that the level of capital holding should increase with riskiness.

The two inequalities after the regulator's objective function are called incentive-compatibility constraints for H-type and L-type banks. We denote them by IC_H and IC_L, respectively. These constraints guarantee that each bank will select the contract appropriate to its type. By choosing the wrong contract, a bank will have to pay a higher cost. Any pair of contracts that satisfy the incentive-compatibility constraints is one of a number of possible solutions.

Case 1: $F_H(1-k_1) \geq F_L(1-k_1)$ for $k_1 \in (0, 1)$

In this case, the minimum cost curve—where the first-order condition is satisfied—for H-type banks is always below the curve for L-type banks (Chart 2).

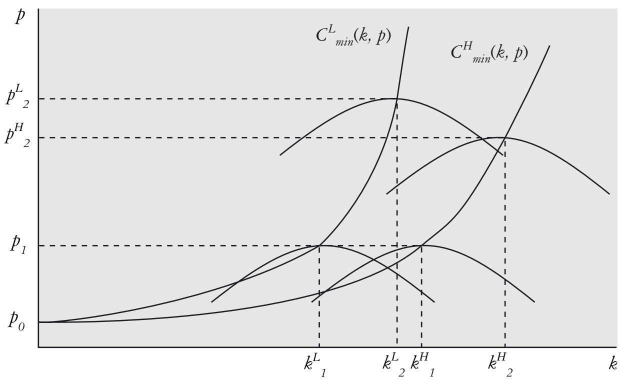
Chart 2 also depicts the iso-cost curve, where the total cost remains constant (reverse U-shaped function). The curvature of the iso-cost curve is easily verified. The slope of the curve is always 0 when it crosses the minimum cost curve. The reason is that, in the case of H-type banks,

$$\left.\frac{dp}{dk}\right|_{C = const} = \frac{F_H(1-k_H)-\eta}{\int_{\bar{r}}^{1-k_H}[(1-k_H)-\tilde{r}]dF_H(\tilde{r})}$$

is zero whenever the first-order condition is satisfied.

Chart 2

MINIMUM COST CURVE: CASE 1



Next, we check the marginal cost. Additional capital will influence the total cost through two different channels. First, it will reduce the range of $\tilde{r}$ in which the penalty is imposed (*penalty cost-saving effect*), so that the more capital the bank holds, the less expected cost it will incur. Second, more capital means the total cost of raising capital increases (*capital cost effect*). On the right-hand-side of the minimum cost curve, the iso-cost curve is downward sloping because the marginal cost is positive. In other words, the capital cost effect exceeds the penalty cost-saving effect, so that the more capital the bank holds, the more costly it is. Hence, to retain the same level of cost, the penalty rate needs to be reduced. On the left-hand-side of the minimum cost curve, the iso-cost curve is upward sloping because the marginal cost is negative. In other words, the penalty cost-saving effect exceeds the capital cost effect, so that the more capital the bank holds, the less costly it is. Hence, to retain the same level of cost, the penalty rate needs to be raised.

Here, the menu of contracts can be incentive compatible. One example of the menu is depicted in Chart 2. If the regulator provides (k_2^L, p_2^L) and (k_2^H, p_2^H), L-type banks will choose the former and H-type banks will choose the latter. The menu options minimise the loss function of the regulator (that is, the menu identifies the level of capital that satisfies the first-order condition, and H-type banks are offered a higher level of capital). The menus also satisfy incentive compatibility, namely that

$$\int_{r-}^{1-k_2^H} p_2^H[(1-k_2^H)-\tilde{r}]dF_H(\tilde{r}) + \eta k_2^H < \int_{r-}^{1-k_2^L} p_2^L[(1-k_2^L)-\tilde{r}]dF_H(\tilde{r}) + \eta k_2^L$$

for an H-type bank and

$$\int_{r-}^{1-k_2^L} p_2^L[(1-k_2^L)-\tilde{r}]dF_L(\tilde{r}) + \eta k_2^L < \int_{r-}^{1-k_2^H} p_2^H[(1-k_2^H)-\tilde{r}]dF_L(\tilde{r}) + \eta k_2^H$$

for an L-type bank.

At the same time, the regulator offering the unique penalty rate also guarantees incentive compatibility because the penalty rate minimises the loss function. To see this point, suppose that the regulator offers p_1 in Chart 2. The pairs of (k_1^L, p_1) and (k_1^H, p_1) are incentive compatible, namely that

$$\int_{r-}^{1-k_1^L} p_1[(1-k_1^H)-\tilde{r}]dF_H(\tilde{r}) + \eta k_1^H < \int_{r-}^{1-k_1^L} p_1[(1-k_1^L)-\tilde{r}]dF_H(\tilde{r}) + \eta k_1^L$$

for an H-type bank and

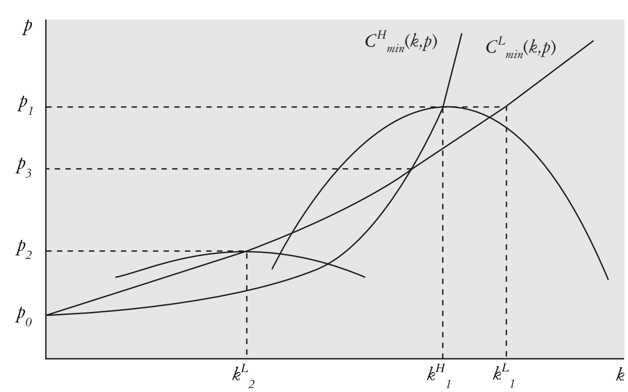
$$\int_{r-}^{1-k_1^L} p_1[(1-k_1^L)-\tilde{r}]dF_L(\tilde{r}) + \eta k_1^L < \int_{r-}^{1-k_1^H} p_1[(1-k_1^H)-\tilde{r}]dF_L(\tilde{r}) + \eta k_1^H$$

for an L-type bank.

Because this model and the original approach satisfy both incentive compatibility and the requirement that riskier banks hold more capital, the menu of contracts with different penalty rates may not be necessary: As long as the single penalty rate is offered by the regulator, the regulator's objective is fulfilled.[10]

Chart 3

MINIMUM COST CURVE: CASE 2



Case 2: $F_H(1-k_i) \geq F_L(1-k_i)$ for k_i close to 0

$F_H(1-k_i) < F_L(1-k_i)$ for k_i close to 1

In case 2, the minimum cost curves intersect at $k > 0$ (Chart 3).

In the precommitment approach, any penalty rate that lies between p_0 and p_3 will yield the same result as in case 1. A problem arises, however, when a penalty rate above p_3 is imposed. Here, the regulator can no longer achieve its objective: Although the capital levels chosen by the banks are incentive compatible, the regulator incurs an additional loss by letting L-type banks hold more capital than H-type banks. Our approach, however, may be able to overcome this problem. Suppose that in Chart 3 the regulator offers two contracts, k_2^L, p_2 and k_1^H, p_1. It is indeed the case that L-type banks choose the first contract and H-type banks choose the second (incentive compatibility is satisfied). Moreover, the regulator achieves its objective by minimising the loss: an additional loss is not incurred as long as H-type banks choose to hold more capital than L-type banks.

We therefore propose two modifications to the precommitment approach. First, the regulator collects necessary information concerning banks' risk characteristics so that it will not impose a penalty rate above p_3. Any penalty rate between p_0 and p_3 will achieve the objective: the regulator will be able to assess each bank's riskiness by observing the level of capital that the bank chooses to hold. Second, the regulator again collects necessary information on banks' riskiness and provides banks with two contracts having different penalty rates. Note that both modifications would require regulators to gather extensive information about banks' risk characteristics.

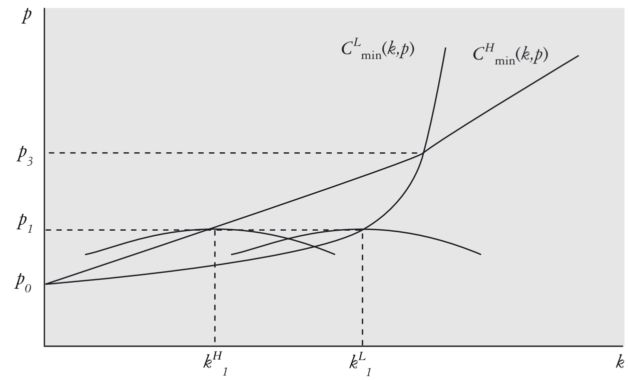
Case 3: $F_H(1-k_i) \leq F_L(1-k_i)$ for k_i close to 0

$F_H(1-k_i) > F_L(1-k_i)$ for k_i close to 1

Our final case is the opposite of case 2 (Chart 4). In the precommitment approach, any penalty rate above p_3 will yield the same result as in case 1, but $p \in (p_0, p_3)$ must be avoided. Unfortunately, our approach may not be able to overcome this difficulty. When one of a pair of contracts deals with a penalty rate below p_3, the regulator's objective cannot be achieved, because H-type banks are

Chart 4

MINIMUM COST CURVE: CASE 3



permitted to hold less capital. To achieve the normative capital requirement, two contracts must thus be offered with penalty rates above p_3. The regulator's objective can also be achieved by offering the single penalty rate as in the precommitment approach, under the condition that the regulator knows p_3, the penalty rate at which the two minimum cost curves intersect. Perhaps it would be simpler to rely on the single penalty rate above p_3—in which case incentive compatibility is automatically satisfied—rather than to design a menu of contracts that requires the regulator to ensure that incentive compatibility is satisfied.

4. CONCLUSION

In this paper, we developed a model from the perspective of mechanism design and demonstrated that, in some cases, the penalty also plays an important role in persuading riskier banks to hold more capital than less risky banks.

In the original precommitment approach framework, the regulator can allegedly discover a bank's riskiness by offering a unique penalty rate. Nonetheless, the appropriate level of capital for each bank depends on the bank's private information, such as the shape of its investment return's density function. Thus, it is not certain that riskier banks always choose to hold more capital than less risky banks.

We then developed a model of mechanism design in which the regulator offers a menu of contracts representing different levels of capital and the corresponding penalty rates. We found that the regulator can implement incentive-compatible contracts in which banks with one level of riskiness voluntarily separate themselves from banks with other levels of riskiness.

We examined three cases. In case 1, if the cumulative density for H-type banks is always greater than the cumulative density for L-type banks, then both the precommitment framework and our approach achieve the regulator's objective: The level of capital holding is equivalent to the amount specified by the first-order condition. In addition, the level of capital holding increases as the bank's riskiness goes up. In this case, it would probably be easier for the regulator to implement the original approach rather than to offer contracts with various penalty rates. In case 2, the cumulative density for H-type banks is greater than the cumulative density for L-type banks for small amounts of capital; the cumulative density is smaller for large amounts of capital. In this instance, our model may be able to achieve the regulator's objective. By contrast, in the precommitment approach, the penalty rate must fall within a particular range; otherwise, the regulator's objective is not completely fulfilled in that incentive compatibility is satisfied but the normative capital requirement is not achieved. In case 3, we examined an instance in which the cumulative density for H-type banks is smaller than the cumulative density for L-type banks for small amounts of capital, whereas cumulative density is greater for large amounts of capital. In case 3, neither approach achieves the regulator's objective as long as either one or two penalty rates take the value where the cumulative density for H-type is smaller. To avoid this, the penalty rate must be set in the range where the cumulative density for H-type is larger. Then, both the precommitment approach and our modification of this approach achieve the regulator's objective. In this instance, it would probably be easier, as in case 1, to implement the original approach.

We have demonstrated that both the precommitment approach and our approach have limitations that prevent them from achieving the optimal result as specified in the regulator's objective function. Here, the key element is how much information the regulator needs to assess banks' risk characteristics. In their recent paper, Kupiec and O'Brien (1997) also note the importance of information to regulators attempting to develop the incentive-compatible regulation. Future research must examine the amount of necessary information and the extent to which there may be a limit to the amount of pressure the regulator can place on banks to disclose their riskiness truthfully.

As we have observed, incentive-compatible contracts cannot be provided unless the regulator obtains certain information. In this sense, incentive-compatible regulation will not replace the traditional role of the regulator as an ex ante monitor of banks: The provision of incentive-compatible contracts and the monitoring by the regulator can be complementary. On a related matter, it has been proposed that the regulator's penalty be replaced by public disclosure. In other words, whenever a bank's actual loss exceeds its precommitted value, the regulator will inform the market of the fact. Such a proposal might be feasible if market participants have the necessary information to assess others' riskiness and if market participants can impose a penalty that satisfies incentive compatibility.

Endnotes

This is a revised version of the paper presented at the conference. The author thanks discussant Pat Parkinson and other participants in the conference, especially Jim O'Brien, for useful comments and criticisms. Any errors are the author's. The views expressed here are the author's and not necessarily those of the Bank of Japan.

1. Kupiec and O'Brien (1995) stress that since the regulator's objective is to let banks precommit levels of capital that satisfy the desired value-at-risk (VaR) capital coverage, it is incentive compatible as long as banks achieve the regulator's goal: Incentive compatibility is allegedly satisfied if they hold the amount of capital that is equivalent to the desired VaR capital requirement.

2. $F(-k)$ in equation 2 is the probability that losses exceed the level of capital, which represents the basis for a VaR capital requirement. In this interpretation of incentive compatibility, it does not matter whether banks with higher risk levels hold higher capital: As long as they hold the right amount of capital consistent with the desired VaR capital requirement, they are regarded as incentive compatible with the regulator's objective. We feel this interpretation is rather unique. Generally speaking, incentive compatibility may not be an instrument that ensures consistency with the principal's objective. There may be a case where a capital requirement is inconsistent with the principal's objective, which nevertheless does not satisfy incentive-compatibility constraints.

3. To be more precise, we take the riskiness of banks as exogenous. This may contradict what Kupiec and O'Brien maintain. The underlying idea of the precommitment approach claims that banks, after being offered a penalty rate, would either commit capital, adjust risk, or do both to satisfy the first-order condition. Here, the riskiness is taken as an endogenous strategy for the banks. Nonetheless, if we view both the risk adjustment and capital holding as endogenous variables, banks do not have any preference-ordering among the pairs of these variables as long as they satisfy the first-order condition. Then there may not be an incentive for banks to "separate." They can be pooled by choosing the same pair. Consequently, the regulator may not need to identify banks' characteristics.

4. To be fair, Kupiec and O'Brien's recent paper (1997) mentions that the regulator should collect information in order to assess banks' risk characteristics.

5. Kupiec and O'Brien are critical of such simplifying assumptions as first-order/second-order stochastic dominance.

6. These cases may not cover all the possibilities. As the bank portfolio becomes more complex, the shape of the distribution becomes more complex as well, and the cumulative densities for H-type and L-type banks may intersect repeatedly. Still, the fundamental idea developed in this section can be applied to more complex cases.

7. Note that the opposite case—in which the cumulative density for H-type is always smaller than the one for L-type—does not exist.

8. Note that we have implicitly assumed that all these events—from case 1 to case 3—take place in the feasible range for the level of capital holding.

9. We have neglected individual rationality constraints for H-type and L-type by simply assuming that the regulator will not offer contracts that exceed the reservation level of cost for both types.

10. This observation implies that the precommitment approach is a special case of our model, where $\rho^L = \rho^H$ (that is, the penalty rates offered to L-type and H-type banks are identical).

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Commentary

Patrick Parkinson

I appreciate the opportunity to participate in this discussion of the pre-commitment approach to achieving regulatory objectives relating to bank capital.

The presenters might reasonably expect the discussant to take up each of their papers in turn, commenting on their strengths and weaknesses and offering an overall assessment of their quality. I am concerned, however, that while the usual approach might best do justice to the presenters, it could leave the audience at something of a loss as to what to make of all this. So I am going to take a different approach. I will begin by briefly reviewing the objective of capital regulation and identifying the factors that make achieving that objective so complex and difficult. In that context, I will then try to frame the debate between proponents of the more traditional approaches to capital regulation and proponents of incentive-based approaches, including the pre-commitment approach, in terms of three basic questions. First, how effective is the current internal models approach to capital for market risk? Second, is the pre-commitment approach a viable alternative? Third, can the two approaches be integrated in ways that play to their respective strengths while avoiding their respective weaknesses? Most of the major arguments made by the presenters will surface in addressing these questions. I shall conclude by offering my own views on these key questions.

Capital Regulation: Objectives and Approaches

In general terms, there seems to be agreement on the objective of capital regulation. Regulators seek to ensure that banks maintain sufficient capital so that banks' portfolio choices fully reflect risks as well as returns. Regulation is necessary because the government safety nets that support banks weaken the incentives for capital adequacy that would otherwise be provided by the market discipline of bank creditors, a phenomenon that is usually called "moral hazard." An important difficulty facing regulators as they attempt to achieve their objective is that the riskiness of banks' portfolios is not readily ascertainable. Traditional approaches to capital regulation have placed ex ante restrictions on bank portfolios that have been based on regulatory risk measurement schemes of lesser or greater sophistication and complexity. Inevitably, however, such regulatory measurement schemes are simpler and less accurate than banks' own risk measurement schemes.

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As a result, such schemes are not incentive-compatible, that is, they do not create incentives for banks to make decisions that produce outcomes consistent with regulatory objectives. To the contrary, they create the motive and the opportunity for banks to engage in regulatory arbitrage that frustrates the achievement of regulatory objectives. Specifically, they create incentives for banks to reduce holdings of assets whose risks are overestimated by regulators and to increase holdings of assets whose risks are underestimated by regulators. Regulators may seek to compensate for such reactions by raising the level of capital requirements, but such actions may intensify the incentives for regulatory arbitrage without meaningfully reducing the opportunities.

Incentive-compatible approaches to capital regulation are intended to solve this problem by inducing banks to take actions that reveal their superior information about the riskiness of their portfolios. In some of these approaches, including the pre-commitment approach, the inducement takes the form of ex post penalties that are imposed on banks in the event that portfolios produce sizable losses. For example, under the pre-commitment approach, a bank would be required to specify the amount of capital it chose to allocate to cover market risks. If cumulative trading portfolio losses over some subsequent interval exceeded the commitment, the bank would be penalized. In principle, the prospect of future penalties would induce banks to commit an amount of capital that reflected their private information on the riskiness of their portfolios.

None of this, it should be emphasized, is news to regulators. In particular, the recent evolution of capital requirements for market risks has reflected a growing recognition of the limitations of supervisory risk measurement schemes, the potential for regulatory arbitrage to undermine achievement of regulatory objectives, and the importance of incentive compatibility. Specifically, the January 1996 amendments to the Basle Accord included an internal models approach (IMA) to setting capital requirements for the market risks of assets and liabilities that are carried in banks' trading accounts. Under the IMA, the capital requirement for a bank that meets certain qualitative and quantitative standards for its risk measurement and risk management procedures is set equal to a multiple of a widely used measure of market risk—so-called value at risk (VaR)—that is estimated using the bank's own internal model. The minimum multiplier was arbitrarily set equal to three. However, subject to this floor, the IMA provided economic incentives for accurate risk measurement by imposing a penalty—a "plus factor" that could increase a bank's VaR multiplier to a maximum of four if the bank fails a "back-test" of its VaR estimates, that is, if its daily trading losses exceeded its VaR estimates with sufficient frequency.

Thus far, however, supervisors have been unwilling to rely more heavily on incentive approaches to capital regulation. In particular, although the Federal Reserve System continues to study the pre-commitment approach, that approach is not currently under active consideration by the Basle Committee. Most regulators seem to believe that the IMA will prove quite effective, and some have openly questioned the viability of the pre-commitment approach.

Effectiveness of the Internal Models Approach

On the efficacy of the internal models approach, Daripa and Varotto characterize it as "a 'hard-link' regime that sets a relation between exposure and capital requirement." They do not mean to imply, however, that VaR is a perfect measure of risk. They acknowledge that VaR is subject to measurement problems and that the use of a fixed holding period in computing VaR ignores management information about the liquidity of markets that might imply that use of a shorter or longer holding period might be appropriate. Still, they seem to think that VaR, if anything, overestimates risk and, therefore, that the IMA is a prudent, if somewhat costly, means of ensuring that regulatory objectives relating to capital are met.

The New York Clearing House Association evidently is more skeptical of the effectiveness of the IMA, although its criticism of the approach is surprisingly oblique. The Clearing House's report does state clearly that the institutions participating in the pilot believe that the minimum multiplier of three results in excessive regulatory capital requirements—the amounts that institutions pre-committed during the pilot generally were significantly less than those implied by applying the minimum multiplier to the firms' internal VaR estimates. Furthermore, they argue that the use of any fixed multiplier, even if it was smaller than three, is not an appropriate means of establishing a regulatory capital requirement. Use of a fixed multiplier constitutes a "one-size-fits-all" approach that they feel does not adequately account for differences in the nature of banks' trading businesses and trading portfolios. Finally, they note that market risk is but one source of risk in a trading business. The participating institutions fear that possible future efforts by regulators to develop capital charges for operational risks (or even legal risks or settlement risks) will be fraught with complications and inefficiencies that could be avoided through use of the pre-commitment approach.

Viability of the Pre-Commitment Approach

On the viability of the pre-commitment approach as an alternative to the IMA, the Clearing House's report asserts that the pilot demonstrates that the approach is a viable alternative to the IMA. In a narrow sense, this is true—the pilot demonstrated that the participating institutions have internal procedures for allocating capital for market risks and other risks in their trading businesses. However, what the pilot did not, and realistically could not, demonstrate is that these internal allocations are sufficiently large to meet regulatory objectives with respect to minimum bank capital. The fact that no participating institution reported a loss in excess of its commitment during the pilot is not compelling. None of the institutions incurred a cumulative loss over any of the four quarters. Hence, no violations would have occurred if no capital was committed. To be fair, without a more precise understanding of the desired loss coverage of regulatory minimum capital requirements, the report could not be expected to demonstrate that pre-commitment is a viable means of meeting that objective.

Both Kobayakawa, and Daripa and Varotto cast doubt on the viability of the pre-commitment approach, at least in its present form. Kobayakawa concludes that a simple penalty—in the form of a fine proportional to the amount by which cumulative losses exceed the capital commitment—would not reliably induce banks to commit amounts of capital commensurate with their private information on their riskiness. In their presentation tomorrow, Paul Kupiec and Jim O'Brien, who developed the theoretical model that motivated the pre-commitment approach, reach the same conclusion. The fundamental problem is that a one-size-fits-all approach to setting penalties would not work. To achieve regulatory objectives reliably, the penalty would need to be bank-specific. Moreover, the appropriate penalty would depend on a bank's cost of capital and on its individual investment opportunities, factors that unfortunately are not ascertainable by regulators.

Daripa and Varotto argue that the effectiveness of the pre-commitment approach could be undermined by principal-agent problems between shareholders and bank managers and that the internal models approach is immune to such problems. The potential importance of agency problems in banking certainly is incontrovertible. When managers or staff have different objectives and incentives than shareholders, shareholders can suffer greatly, as the Barings, Daiwa, and numerous other episodes have made clear. In addition, it may be that agency problems could undermine the pre-commitment approach. What seems implausible, however, is the claim that the IMA avoids such problems. This claim seems to be a corollary of the view that the IMA creates a hard link between risk and capital. To be sure, it creates a hard link between VaR and capital, but VaR and risk are hardly the same thing. To see this, one need only ask—would a VaR-based capital requirement have saved Barings from its fatal agency problem? Clearly not. The fatal positions were hidden from senior management, shareholders, and regulators, and would not have entered into any calculation of VaR nor been covered by a VaR-based capital requirement. Both the IMA and the pre-commitment approach recognize that quantitative controls (VaR measures or penalties, respectively) must be supplemented by qualitative requirements for risk management, including requirements relating to the internal controls that are the only realistic solution to potential agency problems.

Can the Internal Models and Pre-Commitment Approaches Be Integrated?

Although both Kobayakawa, and Daripa and Varotto are critical of the pre-commitment approach as proposed, they are, it should be emphasized, fully appreciative and supportive of incentive-compatible capital regulation. Kobayakawa suggests amending the pre-commitment approach to offer banks a schedule of combinations of ex ante capital requirements and ex post penalties that he claims would induce banks to reveal to regulators their private information about the riskiness of their portfolios. As he claims, his approach would more reliably achieve regulatory objectives than a pre-commitment approach that utilizes a uniform penalty for all banks. Nonetheless, Kobayakawa's alternative faces the same practical difficulties that Kupiec and O'Brien have acknowledged as limiting the effectiveness of the pre-commitment approach and any other incentive-compatible approaches. Specifically, banks will reveal their "riskiness" through their choices from Kobayakawa's menu only if he sets the "schedules" of the capital requirements and penalties quite adroitly. But doing so requires extensive knowledge of banks' portfolio opportunities and capital costs that regulators simply do not (and realistically cannot) possess.

Daripa and Varotto suggest that the pre-commitment approach be amended to provide for use of the IMA as the penalty for violating a pre-commitment. Although they do not provide a formal theoretical justification for their suggestion, they reason that the future prospect of what they see as a hard-link internal models approach would diminish the agency problems that they argue are unique to the pre-commitment approach. As indicated earlier, agency problems are not unique to pre-commitment, nor can they be eradicated by use of a VaR-based capital requirement.

However, an alternative way of looking at their suggestion is as a modification of the IMA. In this regard, it does address some of the concerns that the Clearing House report expressed about the IMA. Daripa and Varotto's suggested approach is not a one-size-fits-all approach, and it would eliminate the minimum and purportedly excessively conservative multiplier of three, at least for banks that had never violated their pre-commitment. Of course, this type of penalty scheme is opposed in the Clearing House report. They argue that the appropriate penalty for violation of a pre-commitment would be public disclosure that a violation had occurred and that regulatory penalties would be unnecessary.

My Own Views on the Issues

My views on the issues raised by the presenters will perhaps please no one. In brief, I see ample room to question the effectiveness of the IMA. But I am sympathetic to regulators' concerns about reliance on a pure incentives-based approach. Thus, I believe consideration should be given to more modest alternatives to the IMA that would loosen but not eliminate ex ante restrictions while enhancing and reorienting the use of ex post penalties.

Regarding the IMA, its essential weakness is the tenuous link between VaR and regulatory capital objectives. VaR is defined as a 99 percent confidence limit for potential losses over a one-day period. But regulators are concerned about the potential for cumulative losses from more extreme price movements over longer time horizons. In such circumstances, application of a multiplier to a bank's VaR estimate is clearly necessary. However, as the Clearing House report argues, the appropriate multiplier needs to be portfolio-specific and probably bank-specific as well, to take account of banks' different abilities to curb losses through active portfolio management. The choice of three as a minimum multiplier no doubt is excessive for some portfolios and may, as the Clearing House report suggests, be too conservative for the portfolios currently held by most banks. In practice, this may provide incentives for banks to focus trading activities on illiquid instruments, such as emerging market currencies and debt instruments, for which even a multiplier of three may be insufficient. Furthermore, because of the tenuous link between VaR and regulatory objectives, back-testing of VaR estimates is of limited value. A bank that passed its back-test could suffer severe losses from future price movements more extreme than those allowed for by the VaR estimates. Conversely, a bank with poor VaR estimates might not be vulnerable to large cumulative losses if its positions were held in very liquid markets and it had the capacity to close out those positions promptly.

Regarding pre-commitment and other incentive-based approaches, they have their own limitations, and those limitations should be recognized. The most recent work by Kupiec and O'Brien has acknowledged that the link between any simple system of ex post penalties and regulatory capital objectives is also tenuous. The penalty appropriate to achieving regulatory objectives relating to capital coverage for trading risks is bank-specific and depends on characteristics that cannot be measured precisely by regulators. Moreover, the efficacy of an approach that relies on ex post penalties to influence bank behavior implicitly assumes that the bank is forward-looking and takes the potential penalties into account when making its current capital allocation. This is a reasonable assumption for healthy banks that are managed as going concerns, but Kupiec and O'Brien have acknowledged that weak banks may not care about future penalties that, in the extreme, might not be enforceable owing to insolvency.

In the end, I find merit in Daripa and Varotto's suggested modification to the pre-commitment approach, although I think it more useful to view it as a modification to the IMA. Institutions would be free to choose a capital allocation for risks in their trading activities—not only market risks but also operational and legal risks—that is less than three times VaR. However, if losses exceeded the capital allocated, the existing IMA would be reimposed for some extended period, presumably with a large "plus factor," that is, a multiplier larger than three. To assuage regulators' legitimate concerns about the limitations of incentive-based approaches, a floor might be placed under the pre-commitment, perhaps expressed as a multiple of VaR. However, to enhance incentives for ongoing improvements in risk management and to diminish incentives for counter-productive and costly regulatory arbitrage, the minimum should be well below the existing minimum of three times VaR.

In effect, this would involve two important changes to the tests and penalties embodied in the existing IMA. First, the back-test would be based not on daily VaR measurement but on cumulative quarterly risk management performance as reflected in the quarterly profit and loss. Second, favorable back-test results, that is, successful efforts to avoid losses in excess of commitments, would be rewarded—in effect, a "minus" would be subtracted from the standard multiplier of three. Furthermore, the minus would not be some arbitrary amount, but instead would reflect banks' judgments about their ability to avoid losses in their trading businesses.

Clearly, these would not be radical changes. But they would be important ones, ones that would relate capital requirements more closely to regulatory objectives and provide stronger incentives for banks to sharpen their skills at risk management rather than their skills at regulatory arbitrage. They would, I believe, be consistent with the widely shared belief that regulatory capital requirements need to continue to evolve, consistent with their basic objectives.

Thank you.

ENDNOTE

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Keynote Address

The Role of Capital in Optimal Banking Supervision and Regulation

by Alan Greenspan

The Role of Capital in Optimal Banking Supervision and Regulation

Alan Greenspan

It is my pleasure to join President McDonough and our colleagues from the Bank of Japan and the Bank of England in hosting this timely conference. Capital, of course, is a topic of never-ending importance to bankers and their counterparties, not to mention the regulators and central bankers whose job it is to oversee the stability of the financial system. Moreover, this conference comes at a most critical and opportune time. As you are aware, the current structure of regulatory bank capital standards is under the most intense scrutiny since the deliberations leading to the watershed Basle Accord of 1988 and the Federal Deposit Insurance Corporation Improvement Act of 1991.

In this tenth anniversary year of the Accord, its architects can look back with pride at the role played by the regulation in reversing the decades-long decline in bank capital cushions. At the time that the Accord was drafted, the use of differential risk weights to distinguish among broad asset categories represented a truly innovative and, I believe, effective approach to formulating prudential regulations. The risk-based capital rules also set the stage for the emergence of more general risk-based policies within the supervisory process.

Of course, the focus of this conference is on the *future* of prudential capital standards. In our deliberations, we must therefore take note that observers both within the regulatory agencies and in the banking industry itself are raising warning flags about the current standard. These concerns pertain to the rapid technological, financial, and institutional changes that are rendering the regulatory capital framework less effectual, if it is not on the verge of becoming outmoded, with respect to our largest, most complex banking organizations. In particular, it is argued that the heightened complexity of these large banks' risk-taking activities, along with the expanding scope of regulatory capital arbitrage, may cause capital ratios as calculated under the existing rules to become increasingly misleading.

I, too, share these concerns. In my remarks this evening, however, I would like to step back from the technical discourse of the conference's sessions and place these concerns within their broad historical and policy contexts. Specifically, I would like to highlight the evolutionary nature of capital regulation and then discuss the policy concerns that have arisen with respect to the current capital structure. I will end with some suggestions regarding basic principles for assessing possible future changes to our system of prudential supervision and regulation.

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To begin, financial innovation is nothing new, and the rapidity of financial evolution is itself a relative concept—what is "rapid" must be judged in the context of the degree of development of the economic and banking structure. Prior to World War II, banks in this country did not make commercial real estate mortgages or auto loans. Prior to the 1960s, securitization, as an alternative to the traditional "buy and hold" strategy of commercial banks, did not exist. Now banks have expanded their securitization activities well beyond the mortgage programs of the 1970s and 1980s to include almost all asset types, including corporate loans. And most recently, credit derivatives have been added to the growing list of financial products. Many of these products, which would have been perceived as too risky for banks in earlier periods, are now judged to be safe owing to today's more sophisticated risk measurement and containment systems. Both banking and regulation are continuously evolving disciplines, with the latter, of course, continuously adjusting to the former.

Technological advances in computers and in telecommunications, together with theoretical advances—principally in option-pricing models—have contributed to this proliferation of ever more complex financial products. The increased product complexity, in turn, is often cited as the primary reason that the Basle standard is in need of periodic restructuring. Indeed, the Basle standard, like the industry for which it is intended, has not stood still over the past ten years. Since its inception, significant changes have been made on a regular basis to the Accord, including, most visibly, the use of banks' internal models to assess capital charges for market risk within trading accounts. All of these changes have been incorporated within a document that is now quite lengthy—and written in appropriately dense, regulatory style.

While no one is in favor of regulatory complexity, we should be aware that capital regulation will necessarily evolve over time as the banking and financial sectors themselves evolve. Thus, it should not be surprising that we constantly need to assess possible new approaches to old problems, even as new problems become apparent. Nor should the continual search for new regulatory procedures be construed as suggesting that existing policies were ill suited to the times for which they were developed or will be ill suited for those banking systems that are at an earlier stage of development.

Indeed, so long as we adhere in principle to a common prudential standard, it is appropriate that differing regulatory regimes may exist side by side at any point in time, responding to differing conditions between banking systems or across individual banks within a single system. Perhaps the appropriate analogy is to computer-chip manufacturers. Even as the next generation of chip is being planned, two or three generations of chip—for example, Pentium IIs, Pentium Pros, and Pentium MMXs—are being marketed, and at the same time, older generations of chip continue to perform yeoman duty within specific applications. Given evolving financial markets, the question is not *whether* the Basle standard will be changed but *how* and *why* each new round of change will occur and to which market segment it will apply.

As it oversees the necessary evolution of the Accord for the more advanced banking systems, the regulatory community would do well to address some of the basic issues that, in my view, it has not adequately addressed to date. In so doing, perhaps we can shed some light on the source of our present concerns with the existing capital standard. There really are only two questions here: First, How should bank "soundness" be defined and measured? Second, What should be the minimum level of soundness set by regulators?

When the Accord was being crafted, many supervisors may have had an implicit notion of what they meant by soundness—they probably meant the likelihood of a bank becoming insolvent. Although by no means the only one, this definition of soundness is perfectly reasonable. Indeed, insolvency probability is the standard explicitly used within the internal risk measurement and capital allocation systems of our major banks. That is, many of the large banks explicitly calculate the amount of capital they need in order to reduce to a targeted percentage the probability, over a given period, that losses would exceed the allocated capital and drive the bank into insolvency.

But whereas our largest banks have explicitly set their own internal soundness standards, regulators really have not. Rather, the Basle Accord set a minimum *capital ratio*, not a maximum *insolvency probability.* Capital, being the difference between assets and liabilities, is of course an abstraction. Thus, it was well understood at the time that the likelihood of insolvency is determined by the level of capital a bank holds, the maturities of its assets and liabilities, and the riskiness of its portfolio. In an attempt to relate capital requirements to risk, the Accord divided assets into four risk "buckets," corresponding to minimum total capital requirements of 0 percent, 1.6 percent, 4.0 percent, and 8.0 percent, respectively. Indeed, much of the complexity of the formal capital requirements arises from rules stipulating which risk positions fit into which of the four capital buckets.

Despite the attempt to make capital requirements at least somewhat risk-based, the main criticisms of the Accord—at least as applied to the activities of our largest, most complex banking organizations—appear to be warranted. In particular, I would note three: First, the formal capital ratio requirements, because they do not flow from any particular insolvency probability standard, are for the most part arbitrary. All corporate loans, for example, are placed into a single, 8 percent bucket. Second, the requirements account for credit risk and market risk but not explicitly for operating and other forms of risk that may also be important. Third, except for trading account activities, the capital standards do not take account of hedging, diversification, and differences in risk management techniques, especially portfolio management.

These deficiencies were understood even as the Accord was being crafted. Indeed, it was in response to these concerns that, for much of the 1990s, regulatory agencies focused on improving supervisory oversight of capital adequacy on a bank-by-bank basis. In recent years, the focus of supervisory efforts in the United States has been on the internal risk measurement and management processes of banks. This emphasis on internal processes has been driven partly by the need to make supervisory policies more risk-focused in light of the increasing complexity of banking activities. In addition, this approach reinforces market incentives that have prompted banks themselves to invest heavily in recent years to improve their management information systems and internal systems for quantifying, pricing, and managing risk.

It is appropriate that supervisory procedures evolve to encompass the changes in industry practices, but we must also be sure that improvements in both the form and the content of the formal capital regulations keep pace. Inappropriate regulatory capital standards, whether too low or too high in specific circumstances, can entail significant economic costs. This resource allocation effect of capital regulations is seen most clearly by comparing the Basle standard with the internal "economic capital" allocation processes of some of our largest banking companies. For internal purposes, these large institutions attempt explicitly to quantify their credit, market, and operating risks by estimating loss probability distributions for various risk positions. Enough economic, as distinct from regulatory, capital is then allocated to each risk position to satisfy the institution's own standard for insolvency probability. Within credit risk models, for example, capital for internal purposes often is allocated so as to hypothetically "cover" 99.9 percent or more of the estimated loss probability distribution.

These internal capital allocation models have much to teach the supervisor and are critical to understanding the possible misallocative effects of inappropriate capital rules. For example, the Basle standard lumps all corporate loans into the 8 percent capital bucket, but the banks' internal capital allocations for individual loans vary considerably—from less than 1 percent to well over 30 percent—depending on the estimated riskiness of the position in question. In the case in which a group of loans attracts an *internal* capital charge that is very low compared with the Basle 8 percent standard, the bank has a strong incentive to undertake regulatory capital arbitrage to structure the risk position in a manner that allows it to be reclassified into a lower *regulatory* risk category. At present, securitization is, without a doubt, the major tool used by large U.S. banks to engage in such arbitrage.

Regulatory capital arbitrage, I should emphasize, is not necessarily undesirable. In many cases, regulatory capital arbitrage acts as a safety valve for attenuating the adverse effects of those regulatory capital requirements that are well in excess of the levels warranted by a specific activity's underlying economic risk. Absent such arbitrage, a regulatory capital requirement that is inappropriately high for the economic risk of a particular activity could cause a bank to exit that relatively low-risk business by preventing the bank from earning an acceptable rate of return on its capital. That is, arbitrage may appropriately lower the effective capital requirements against some safe activities that banks would otherwise be forced to drop by the effects of regulation.

It is clear that our major banks have become quite efficient at engaging in such desirable forms of regulatory capital arbitrage, through securitization and other devices. However, such arbitrage is not costless and therefore not without implications for resource allocation. Interestingly, one reason that the formal capital standards do not include very many risk buckets is that regulators did not want to influence how banks make resource allocation decisions. Ironically, the "one-size-fits-all" standard does just that, by forcing the bank into expending effort to negate the capital standard, or to exploit it, whenever there is a significant disparity between the relatively arbitrary standard and internal, *economic* capital requirements.

The inconsistencies between internally required economic capital and the regulatory capital standard create another type of problem: Nominally high regulatory capital ratios can be used to mask the true level of insolvency probability. For example, consider the case in which the bank's own risk analysis calls for a 15 percent internal economic capital assessment against its portfolio. If the bank actually holds 12 percent capital, it would, in all likelihood, be deemed to be well capitalized in a regulatory sense, even though it might be undercapitalized in the economic sense.

The possibility that regulatory capital ratios may mask true insolvency probability becomes more acute as banks arbitrage away inappropriately high capital requirements on their safest assets by removing these assets from the balance sheet via securitization. The issue is not solely whether capital requirements on the bank's residual risk in the *securitized* assets are appropriate. We should also be concerned with the sufficiency of regulatory capital requirements on the assets remaining on the book. In the extreme, such "cherry picking" would leave on the balance sheet only those assets for which *economic* capital allocations are greater than the 8 percent *regulatory* standard.

Given these difficulties with the one-size-fits-all nature of our current capital regulations, it is understandable that calls have arisen for reform of the Basle standard. It is, however, premature to try to predict exactly how the next generation of prudential standards will evolve. One set of possibilities revolves around market-based tools and incentives. Indeed, as banks' internal risk measurement and management technologies improve, and as the depth and sophistication of financial markets increase, bank supervisors should continually find ways to incorporate market advances into their prudential policies, when appropriate. Two potentially promising applications of this principle have been discussed at this conference. One is the use of internal credit risk models as a possible substitute for, or complement to, the current structure of *ratio-based* capital regulations. Another approach goes one step further and uses market-like incentives to reward and encourage improvements in internal risk measurement and management practices. A primary example is the proposed precommitment approach to setting capital requirements for bank trading activities. I might add that precommitment of capital is designed to work for only the trading account, not the banking book, and then for only strong, well-managed organizations.

Proponents of an internal-models-based approach to capital regulations may be on the right track, but at this moment of regulatory development, it would seem that a full-fledged, bankwide, internal models approach could require a very substantial amount of time and effort to develop. In a paper given earlier today, Federal Reserve Board economists David Jones and John Mingo enumerate their concerns about the reliability of the current generation of credit risk models. They suggest, however, that these models may, over time, provide a basis for setting future regulatory capital requirements. Even in the shorter term, they argue, elements of internal credit risk models may prove useful within the supervisory process.

Still other approaches are of course possible, including some combination of market-based and traditional ratio-based approaches to prudential regulation. But regardless of what happens in this next stage, as I noted earlier, any new capital standard is itself likely to be superceded within a continuing process of evolving prudential regulations. Just as manufacturing companies follow a product-planning cycle, bank regulators can expect to begin working on still another generation of prudential policies even as proposed modifications to the current standard are being released for public comment.

In looking ahead, supervisors should, at a minimum, be aware of the increasing sophistication with which banks are responding to the existing regulatory framework and should now begin active discussions on the necessary modifications. In anticipation of such discussions, I would like to conclude by focusing on what I believe should be several core principles underlying any proposed changes to our current system of prudential regulation and supervision.

First, a reasonable principle for setting regulatory soundness standards is to act much as the market would if there were no safety net and all market participants were fully informed. For example, requiring all of our regulated financial institutions to maintain insolvency probabilities that are equivalent to a triple-A rating standard would be demonstrably too stringent because there are very few such entities among *unregulated* financial institutions *not* subject to the safety net. That is, the markets are telling us that the value of the financial firm is not, in general, maximized at default probabilities reflected in triple-A ratings. This suggests, in turn, that regulated financial intermediaries cannot maximize their value to the overall economy if they are forced to operate at unreasonably high levels of soundness.

Nor should we require individual banks to hold capital in amounts sufficient to protect fully against rare systemic events, which, in any event, may render standard probability evaluation moot. The management of systemic risk is properly the job of the central banks. Individual banks should not be required to hold capital against the possibility of overall financial breakdown. Indeed, central banks, by their existence, appropriately offer banks a form of catastrophe insurance against such events.

Conversely, permitting regulated institutions that benefit from the safety net to take risky positions that, in the absence of the net, would earn them junk bond ratings for their liabilities is clearly inappropriate. In such a world, our goals of protecting taxpayers and reducing the misallocative effects of the safety net would simply not be realized. Ultimately, the setting of soundness standards should achieve a complex balance—remembering that the goals of prudential regulation should be weighed against the need to permit banks to perform their essential risk-taking activities. Thus, capital standards should be structured to reflect the lines of business and the degree of risk taking chosen by the individual bank.

A second principle should be to continue linking strong supervisory analysis and judgment with rational regulatory standards. In a banking environment characterized by continuing technological advances, this means placing an emphasis on constantly improving our supervisory techniques. In the context of bank capital adequacy, supervisors increasingly must be able to assess sophisticated internal credit risk measurement systems and to gauge the impact of the continued development in securitization and credit derivative markets. It is critical that supervisors incorporate, where practical, the risk analysis tools being developed and used on a daily basis within the banking industry itself. If we do not use the best analytical tools available and place these tools in the hands of highly trained and motivated supervisory personnel, then we cannot hope to supervise under our basic principle—supervision as if there were no safety net.

Third, we have no choice but to continue to plan for a successor to the simple risk-weighting approach to capital requirements embodied within the current regulatory standard. While it is unclear at present exactly what that successor might be, it seems clear that adding more and more layers of arbitrary regulation would be counterproductive. We should, rather, look for ways to harness market tools and market-like incentives whenever possible, by using banks' own policies, behaviors, and technologies in improving the supervisory process.

Finally, we should always remind ourselves that supervision and regulation are neither infallible nor likely to prove sufficient to meet all our intended goals. Put another way, the Basle standard and the bank examination process, even if structured in optimal fashion, are a second line of support for bank soundness. Supervision and regulation can never be a substitute for a bank's own internal scrutiny of its counterparties and for the market's scrutiny of the bank. Therefore, we should not, for example, abandon efforts to contain the scope of the safety net or to press for increases in the quantity and quality of financial disclosures by regulated institutions.

If we follow these basic prescriptions, I suspect that history will look favorably on our attempts at crafting regulatory policy.

Session 5

International Capital Allocation at Financial Institutions

Papers by

Tim Shepheard-Walwyn and Robert Litterman

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Commentary by

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Building a Coherent Risk Measurement and Capital Optimisation Model for Financial Firms

Tim Shepheard-Walwyn and Robert Litterman

I. Introduction

Risk-based capital allocation methodologies and regulatory capital requirements have assumed a central importance in the management of banks and other financial firms since the introduction of the Basle Committee's Capital Accord in 1988. However, as firms have progressively developed more sophisticated techniques for measuring and managing risk, and as regulators have begun to utilise the output of internal models as a basis for setting capital requirements for market risk, it is becoming increasingly clear that the risk as measured by these models is significantly less than the amount of equity capital that the firms themselves choose to hold.[1]

In this paper, we therefore consider how risk measures, based on internal models of this type, might be integrated into a firm's own methodology for allocating risk capital to its individual business units and for determining its optimal capital structure. We also consider the implications of these developments for the future approach to determining regulatory capital requirements.

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II. Why Do Financial Firms Need Internal Risk Measurement and Risk-Based Capital Allocation Methodologies?

The core challenge for the management of any firm that depends on external equity financing is to maximise shareholder value. To do this, the firm has to be able to show at the margin that its return on investment exceeds its marginal cost of capital. In the context of a nonfinancial firm, this statement is broadly uncontentious. If the expected return on an investment can be predicted, and its cost is known, the only outstanding issue is the marginal cost of capital, which can be derived from market prices for the firm's debt and equity.

In the case of banks and other financial firms, however, this seemingly simple requirement raises significant difficulties. In the first place, the nature of risk in financial markets means that, without further information about the firm's risk profile and hedging strategies, even the straightforward requirement to be able to quantify the expected return on an investment poses problems. Second, the funding activities of financial firms do not provide useful signals about the marginal cost of capital. This is because, for the majority of large and well-capitalised financial firms, the marginal cost of funds is indifferent to day-to-day changes in the degree of leverage or risk in their balance sheets. This, in turn, leads to a third problem, which is how to determine the amount of capital that the firm should apply to any particular investment. For a nonfinancial company, the amount of capital tied up in an investment can be more or less equated to the cost of its investment. However, in the case of a financial firm, where risk positions often require no funding at all, this relationship does not hold either.

It therefore follows that a financial firm that wants to maximise shareholder value cannot use the relatively straightforward capital pricing tools that are available to nonfinancial firms, and must seek an alternative shadow pricing tool to determine whether an investment adds to or detracts from shareholder value. This is the purpose that is served by allocating risk capital to the business areas within a financial firm.

III. Risk Measurement, Shadow Pricing, and the Role of the Sharpe Ratio

Since the objective of maximising shareholder value can be achieved either by increasing the return for a given level of risk, or alternatively by reducing the risk for a given rate of return, the internal shadow pricing process needs to be structured in a way that will assist management in achieving this objective. In other words, the shadow pricing tool has to have as its objective the maximisation of the firmwide Sharpe Ratio, since the Sharpe Ratio is simply the expression of return in relation to risk. Seen in these terms, we can draw a number of important conclusions that will assist us in determining how we should build our shadow pricing process.

First, and importantly, the shadow pricing process should operate in a manner that is independent of the level of equity capital in the firm. This follows because, where the perceived risk of bankruptcy is negligible, as is the case for most large financial firms, the Sharpe Ratio is independent of the amount of equity within a firm (see appendix). Thus, for any given set of assets, the amount of equity the firm has does not alter the amount of risk inherent in the assets, it merely determines the proportion of the risk that is assumed by its individual equity holders. Consequently, for any given level of equity, shareholder value can always be enhanced either by increasing the ex post rate of return for the given level of risk, or more importantly for a bank, which has little scope for significantly enhancing the earnings on its loan portfolio, by reducing the variance of those earnings through improved portfolio management.

Second, if the purpose of the process is to maximise the firm's Sharpe Ratio by encouraging risk-optimising behaviour, it has to capture all the important components of a firm's earnings volatility. The Sharpe Ratio that is relevant to the investor is simply the excess return on the firm's equity relative to the volatility of that return.

In ex post terms, this can be expressed as:

$$Sharpe\ Ratio_t = \frac{R_{pt} - R_{ft}}{\sigma_{pt}},$$

where

R_{pt} is the observed firmwide return on the investment in time t,

R_{ft} is the return on the risk-free rate at time t, and

σ_t is the standard deviation of R_{pt} measured at time t.

Management's objective at time t is therefore to maximise the expected Sharpe Ratio over the future period $t+1$. In order to do this, management has to be able to predict R_{pt+1} and σ_{t+1}. This means that we need to be able to understand both the components of $E(R_{pt+1})$ and the determinants of its variance, σ_{t+1}.

In a simple model of the firm, we can express $E(R_{pt+1})$ as follows:

$$E(R_{pt+1}) = E(\Delta P_{t+1} + Y_{t+1} - C_{t+1}),$$

where

$E(R_{pt+1})$ is the forecast value of earnings in time $t+1$,

ΔP_{t+1} is the change in the value of the firm's portfolio of assets in time $t+1$,

Y_{t+1} is the value of the firm's new business revenues in time $t+1$, and

C_{t+1} is the costs that the firm incurs in time $t+1$.

We can express $Var(R_{pt+1})$ as σ^2_{t+1}, so that by definition:

$$\begin{aligned}\sigma^2_{t+1} = {} & \sigma^2 \Delta P_{t+1} + \sigma^2 Y_{t+1} + \sigma^2 C_{t+1} \\ & + 2(Cov(\Delta P_{t+1}, Y_{t+1}) - Cov(\Delta P_{t+1}, C_{t+1}) \\ & - Cov(Y_{t+1}, C_{t+1})).\end{aligned}$$

Because this is a forward-looking process, the firm cannot rely solely on observed historical values. It needs to be able to estimate their likely values in the future. The firm must therefore understand the dynamics of each of ΔP_{t+1}, Y_{t+1}, and C_{t+1}, and in particular the elements that contribute significantly to both their variance and covariance. These are the risk drivers of the business, which need to be identified and modeled if the firm is to have an effective shadow pricing process for its risk.

As a result of this approach, it is possible to think in terms of a generic risk pricing approach for maximising shareholder value, using generally agreed-upon risk pricing tools that could be applicable to all financial firms. Just as value at risk measures for market risk have become a common currency for comparing and analysing market risk between firms, a similar approach to other risk factors could readily be developed out of this model.

IV. Determining the Optimal Capital Structure for the Firm

As we have explained, there is no causal link between the level of gearing that a firm chooses and its Sharpe Ratio. However, this is subject to one important caveat, which is that the amount of equity capital that a firm holds has to be large enough to enable it to survive the "normal" variability of its earnings. This means that at the minimum, a firm will need to have some multiple of its expected earnings volatility—$(\sigma_{t+1})k$, where k is a fixed multiplier—as equity capital. Failure to maintain such an amount should lead to a risk premium on the firm's equity, which would make the cost of capital prohibitive. In most cases, though, management will choose to operate in some excess of this minimum level.

The question we therefore need to address here is how much equity capital in excess of $(\sigma_{t+1})k$ will a well-managed firm choose to hold, and how should it reach that decision?

Although by definition the amount of equity that the firm chooses will itself be a multiple of $E(\sigma_{t+1})k$,[2] the methodology for deciding how to set that amount needs to be significantly different from the methodology by which the shadow pricing amount σ_{t+1} is determined. This is so for three reasons. First, financial markets are prone to the characteristics of fat tails, which means that it is dangerous to rely solely on the properties of statistical distributions to predict either the frequency or the size of extreme events. Given that one of the responsibilities of the management of a financial firm is to ensure the continuity of that firm in the long term—which will in turn help to ensure that the perceived risk of bankruptcy is kept to a minimum—the firm needs to be able to analyse the nature of these rare events and ensure that the capital and balance-sheet structure are robust enough to withstand these occurrences and still be able to continue in business thereafter.

Thus, while in the case of certain risk factors the potential stress or extreme loss that the firm faces and needs to protect against may indeed be best estimated by an extension of the statistical measures used to calculate σ_{t+1}, in other cases the results of scenario analysis may yield numbers well in excess of the statistical measure. (The 1987 market crash, for example, was a 27 standard deviation event—well outside the scope of any value-at-risk measure.) As a result, statistical techniques that are applicable to a risk pricing process need to be supplemented with effective scenario and stress analysis techniques in order for management to assess the potential scale of the firm's exposure to such extreme events.

The second consideration in managing the firm's capital is how to optimise the firm's equity structure in an imperfect world. In theory, in the absence of any significant risk of bankruptcy, the market should be indifferent between different levels of leverage for firms with the same Sharpe Ratio, but it is not clear that this is the case. In particular, highly capitalised banks, which should have lower target returns on equity to compensate for their lower risk premia, appear to remain under pressure to provide similar returns on equity to more thinly capitalised firms.

Third, management has the additional requirement to ensure that it complies with regulatory capital requirements, set by reference to regulatory measures of risk, which often do not correspond with internal risk measures and in many cases conflict with them.

This means that one of the principal strategic considerations for management is to optimise the capital structure, bearing in mind the three different considerations of protecting the firm against catastrophic loss, meeting shareholder expectations, and complying with external regulatory requirements.

The essential requirement for this optimisation exercise is to ensure that the two following conditions are always met:

$$(\sigma_{t+1})k_i \leq Total\ Capital_i, \qquad \text{(Condition 1)}$$

where

$(\sigma_{t+1})k_i$ is the minimum level of capitalisation at which firm *i* can raise capital funds in the market for its given level of risk, and $Total\ Capital_i$ is the amount of capital that the firm actually holds

and

$$Regulatory\ Capital_i \leq Total\ Capital_i, \qquad \text{(Condition 2)}$$

where

$Regulatory\ Capital_i$ is the amount of capital that firm *i* is required to hold under the existing regulatory capital regime.

This formulation shows clearly why in a shadow pricing approach to risk, based on the calculation of σ_{t+1}, the amount of capital at risk and therefore being charged to the business is always likely to be less than the total capital of the firm.

Furthermore, from the perspective of the firm, the preferable relationship between these three considerations would also be such that

$$(\sigma_{t+1})k_w < Regulatory\ Capital_w < Optimal\ Capital_w, \qquad \text{(Condition 3)}$$

where

$Optimal\ Capital_w$ is the amount of capital that the firm would choose for itself in the absence of a regulatory constraint.

Where this condition can be met, the firm can concentrate solely on optimising its capital structure and maximising shareholder value without having to factor considerations about the impact of a regulatory capital regime into its optimisation exercise.

For completeness, we can also note here that the further necessary condition should exist from the regulatory perspective for any regulatory capital regime to be appropriately represented as risk-based, which is

$$(\sigma_{t+1})k_i \leq Regulatory\ Capital_i, \qquad \text{(Condition 4)}$$

so that the risk-based regulatory capital requirement is at least consistent with the market's assessment of the minimum amount of capital a firm should have in order to protect against the risk inherent in its business. This, in turn, by combining Conditions 2 and 4, leads us to the minimum requirement for a satisfactory regulatory capital regime that

$$(\sigma_{t+1})k_w \leq Regulatory\ Capital_i \leq Total\ Capital_i. \qquad \text{(Condition 5)}$$

We return to this issue, and in particular the relationship between the regulatory requirements and optimal capital structure for the firm in more detail in Section VI.

V. Risk Measurement—The Challenge of Normalisation

Now that we have distinguished between the different purposes of risk measurement for shadow pricing of risk and for the determination of the optimal capital structure, we can move on to consider the challenges of building an effective risk measurement system. The objective here is to enable management to assess the different risks that a firm faces in a broadly similar fashion, and to understand their interrelationships. This requires both a common measurement framework and a methodology for ensuring that the risk process covers all the material risks that may impact the shadow pricing process or the decisions about the capital structure.

At the outset, a firm has to have a clear understanding of the meaning of risk if it is to develop an effective risk measurement methodology. For the purposes of this paper, we can define the risk in a firm on an ex post basis as the observed volatility of the firm's earnings over time around a mean value. The firm's risk measures are thus the firm's best estimates of that volatility, which management can then use to make choices between different business strategies and investment decisions and to determine the firm's capital structure.

In order to achieve this, it is necessary to distinguish between the three measures of expected, unexpected, and stress loss as follows.

The *expected loss* associated with a risk factor is simply the expected value of the firm's exposure to that risk factor. It is important to recognise that expected loss is not itself a risk measure but is rather the best estimate of the economic cost of the firm's exposure to a risk. The clearest example of this at present is the treatment of credit risk, where banks know that over the credit cycle they will incur losses with a high probability, but only account for those losses as they occur. This introduces a measure of excessive volatility into the firm's reported earnings, which is not a true measure of the "risk," given that the defaults are predictable with a high degree of confidence. The true risk is only that part of the loss that diverges from the expected value.

Having established the expected loss associated with a risk, it is then possible to measure the variance of that cost in order to establish the extent to which it contributes to the overall variance of the firm's earnings, which we term the *unexpected loss* associated with the risk factor. Both VaR for market risk and the credit risk measures produced by CreditMetrics and CreditRisk+ are examples of measures of unexpected loss that can be used in an internal risk pricing process of the type discussed in Section III. However, comparison of these two approaches also points up the significance of adopting different time horizons in measuring different risks.

VaR measures for market risk are typically either a one-day or ten-day measure of risk. By contrast, the modeling of default risk, which is still at an early stage of development, typically utilises an annual observation period, since default frequencies change over a much longer time horizon than market prices. As a result of these different time horizons, a ten-day 99 percent confidence interval for market risk would imply that the VaR limit could be expected to be exceeded once every three years. An annually based VaR of 97.5 percent for credit risk, however, would be expected to be exceeded only once every forty years. Aggregating the two measures into a single measure of the firm's risk—even assuming for the moment that the firm's market and credit risk were independent—would not provide a satisfactory indication of the aggregate risk that the firm faces.

A further problem with the estimation of unexpected losses is the availability of reliable data for the different risk factors that a firm faces. Significant progress has been made on measuring market risk because of the availability of daily data for prices and for revenues within firms, and more recently progress has also been made on modeling credit risk, although here the data quality problem is proving more challenging. In the case of other risk factors such as liquidity, legal, and operational risks, however, the analysis is likely to have to rely on firms' own internal data, and very little work has yet been undertaken to examine the statistical properties of those risks. Moreover, meaningful estimates of the covariances between risk factors will only be possible once reliable estimates can be made of unexpected loss on a stand-alone basis.

In addition to the need to develop expected and unexpected loss measures, which are particularly relevant to the firm's risk pricing methodology, the firm also has to have a methodology for determining the extreme or *stress loss* that it might face over the longer term horizon as a result of its exposure to a risk factor in order to make meaningful decisions about its capital structure and risk limits systems. A number of risk measures and limits, such as the concentration limits that banking regulators use to limit the proportion of a bank's capital that can be at risk to any one counterparty, are derived explicitly or implicitly from this type of measure. The methodology that a firm may choose for calculating the potential stress loss associated with a particular risk will vary from risk factor to risk factor, but will typically consist of a form of scenario simulation, which envisions the type of situation where the firm could potentially be put at risk from a particular risk factor, or a combination of factors, and then assesses the firm's capital resources and limits structures by reference to the results of this exercise.

Given that the purpose of measuring risk is to estimate the exposure of the firm to earnings variability from its principal risk drivers, the firm also needs to have a factor model that identifies the key risk factors to which it is exposed and measures their impact on the volatility of the earnings stream. The issue we now need to address is, What are these risk drivers and how can they be measured effectively?

In order to establish a starting point for this exercise, we can use the 1994 Basle Committee paper on risk management for derivatives, which identified six risks that firms face—market risk, credit risk, settlement risk, liquidity risk, legal risk, and operational risk. If we relate this list back to the shadow pricing equation in Section III, we can readily see how much still remains to be done in establishing an effective internal risk pricing process.

As we discussed in Section III, firms have started this process by analysing their trading exposure to *market risk*, which is where the data are most readily available. It is interesting to note, however, that even in the context of market risk, few firms are yet able to measure their overall revenue exposure from areas such as corporate finance or funds management to movements in market variables, even though these may be significantly more powerful factors in determining the quality of their earnings in the medium term, not least because the time horizons are different.

In a manner similar to their work on market risk, firms have turned their attention more recently to the issues associated with the measurement of the unexpected loss associated with *credit risk*. Work in this area derives from two parallel initiatives. On the one hand, there has been increasing interest, stimulated in considerable part by the Basle Committee's model-based approach to capital requirements for market risk, in developing models of the specific risk in the trading book. On the other hand, there has been an increasing effort to develop reliable models for measuring the default risk in the banking book.

The third category of risk identified in the 1994 paper in the context of derivative products was *settlement risk*. In practice, settlement risk is a special case of credit risk, since it arises from the failure of a counterparty to perform on a contract. Its particular characteristic is that it arises on a daily basis as transactions—particularly in foreign exchange and payments business—are settled, and the magnitude of the daily exposure between different financial institutions in relation to settlement risk is many times larger than for other risk factors. The primary challenge for a financial firm is therefore to be able to capture and monitor its settlement risk in a timely manner. Once this has been done, the same methodology for measuring expected and unexpected loss can be applied to settlement risk as for other types of credit risk.

To date, the techniques for measuring *liquidity risk* have tended to focus on the potential stress loss associated with the risk, whether in the form of the cash capital measure used by the U.S. securities firms or the funding gap analysis undertaken by bank treasuries. Both are attempts to quantify what might occur in extreme cases if the firm's funding sources dried up. While this is clearly a prudent and desirable part of corporate financial management, it should also be possible to apply the framework of expected and unexpected loss to liquidity risk by measuring the extent to which the liquidity risk inherent in the business gives rise to costs in hedging out that risk through the corporate treasury function.

In a similar way to the approach to liquidity risk, the focus to date in analysing the impact of *legal risk* and other aspects of *operational risk* has been in seeking to prevent the serious problems that have given rise to the well-publicised losses, such as those of Hammersmith and Fulham in the context of legal risk, or those of Barings and Daiwa Bank in the context of operational risk more generally. As with liquidity risk, however, the issue that has yet to be addressed in the context of internal risk pricing is how these risk factors contribute to the earnings volatility of the firm, since operational risk can be seen as a general term that applies to all the risk factors that influence the volatility of the firm's cost structure as opposed to its revenue structure. It is therefore necessary for the firm to classify and analyse more precisely the nature of these risk factors before any meaningful attempt can be made to fit them into a firmwide risk model of the type envisaged by this paper.

As the foregoing analysis indicates, a considerable amount of further work clearly still remains to be undertaken in the development of risk modeling in financial firms. Nevertheless, despite the evident gaps in the development of a full risk model, this does not preclude proceeding to implement a risk pricing methodology for those risks that can be measured. This is because with risk pricing there is no presumption that the risk measures should add to the total capital of the firm, and thus there is no danger of misallocating capital to the wrong business, which can occur if a risk-based capital allocation model is used with an incomplete risk model. Given this fact, the integrity of the risk measure for the particular risk factor is the primary consideration, and the need for a strict normalisation of risk measures—so that the measures for each risk factor can be aggregated on a consistent "apples for apples" basis—assumes a lesser importance as an immediate objective.

VI. Risk Allocation Methodologies and Regulatory Capital Requirements—A Synthesis?

Having outlined the components of an integrated approach to risk pricing and capital optimisation within financial firms, we can now consider the implications of this analysis for the structure of a satisfactory regulatory capital framework. In this context, we do not seek to analyse the different rationales for capital regulation, but simply note that it is now widely accepted that any regulatory capital requirement should be risk-based and should be consistent with firms' own internal risk measurement methodologies, so that a firm that carries more risk is subject to a higher capital requirement than one that carries less risk.

As we have explained, the core objective of a firm's own internal risk pricing mechanism should be to enhance shareholder value by encouraging behaviour that will improve the firm's overall Sharpe Ratio. In normal circumstances, this will be separate from the process of determining the optimal capital structure for the firm. The difference between the two is that the risk pricing exercise is based on a measure of unexpected loss and is designed to operate at the margin, at the level of the individual business decision. The decision on the capital structure should, by contrast, be based on an assessment of stress loss scenarios and be independent of activity at the margin, leading to the minimum capital condition that, identified in Section III, that

$$(\sigma_{t+1})k_i \le Total\ Capital_i . \qquad \text{(Condition 1)}$$

In Section III, we also derived the following minimum condition, which we believe should be satisfied in order to characterise a regulatory capital regime as adequately risk-based

$$(\sigma_{t+1})k_i \le Regulatory\ Capital_i \le Total\ Capital_i , \qquad \text{(Condition 5)}$$

and we identified the desirable condition for a well-managed and well-capitalised firm that

$$(\sigma_{t+1})k_w < Regulatory\ Capital_w < Optimal\ Capital_w . \qquad \text{(Condition 3)}$$

We can now assess how these requirements compare under three alternative approaches to setting regulatory capital requirements, which can be summarised as follows:

- the fixed ratio approach (Basle 1988/CAD/SEC net capital rule)
- the internal measures approach (Basle market risk 1997/Derivatives Policy Group proposals)
- the precommitment approach.

The *fixed ratio approach* calculates the required regulatory capital for a financial firm by reference to a regulatory model of the "riskiness" of the firm's balance sheet. The problem associated with any regime of this sort, which seeks to impose an arbitrary measure of the riskiness of a firm's business on a transaction-by-transaction basis, is that there is no mechanism for testing it against the true risk in the firm, which will by definition vary from firm to firm. As a result, the only part of Conditions 3 and 5 that this approach can satisfy a priori is that

$$Regulatory\ Capital_i \le Total\ Capital_i ,$$

which is achieved by regulatory requirement. But Condition 1 is violated because we cannot be sure that

$$(\sigma_{t+1})k_i \le Regulatory\ Capital_i$$

and equally, there is no way of ensuring for a well-managed firm that Condition 3 can be met because there is no mechanism for ensuring that

$$Regulatory\ Capital_w < Optimal\ Capital_w .$$

Given these flaws, it is difficult to see how a fixed ratio regime could realistically be adapted to meet our conditions for an optimal capital structure.

By comparison with the fixed ratio approach, the *internal models approach* is clearly preferable from the viewpoint of the well-managed firm, since it seeks to equate regulatory capital to

$$(\sigma_{t+1})m,$$

where m is the regulatory multiplier.

If we assume that m is set at a level that is higher than k (the minimum capital requirement for a viable firm) but at a level that is still economic, it is likely that the well-managed firm will be able to live with this regime, provided it has a sufficient margin of capital between $(\sigma_{t+1})m_w$ and $Optimal\ Capital_w$.

However, it is questionable whether such a "full models" regime is genuinely optimal, or could be introduced quickly, since neither the industry nor the regulators are yet able to define the model that determines σ_{t+1} for the whole firm. Consequently, a decision to use a full models approach for regulatory capital purposes would commit both regulators and financial firms to a significant investment of resources, with an indeterminate end date, and would at the same time provide no assurance that the outcome was superior to a simpler and less resource-intensive approach.

The *precommitment approach*, by contrast with either the fixed ratio or internal models approach, has the attraction of simplicity and synergy with the firm's own processes since it allows firms to determine their own capital requirement for the risks they face. If the regulators are able to ascertain that the firm's internal procedures are such as to ensure that

$$(\sigma_{t+1})k_i \leq Total\ Capital_i$$

with sufficient margin to satisfy the regulatory needs for capital, then precommitment in its most complete sense has the simple result that

$$(\sigma_{t+1})k \leq Total\ Capital_i \equiv Regulatory\ Capital_i,$$

which satisfies the requirements of our three conditions.

However it is questionable whether a full precommitment approach, as outlined, can be defined as a regulatory capital regime at all. It would probably be better described as an internal controls regime, since in substance it would mean that the regulator would review the methodology whereby the firm undertook its risk pricing and capital structuring decisions and would either approve them—allowing precommitment—or impose a capital requirement if they were not satisfied with the process. In addition, the regulatory authority would be susceptible to criticism, in the event that a problem was encountered at a firm that had been allowed to employ the precommitment approach, that it had unnecessarily foregone an important regulatory technique.

Given the evident problems of a move that is as radical as the precommitment proposal, we therefore believe that it is worthwhile to consider a fourth approach, which we refer to as the *base plus* approach. Under this approach, the regulator would determine directly on a firm-by-firm basis the regulatory capital requirement for the forthcoming period as an absolute amount, say R_{t+1}, based on some relatively simple rules such as a multiple of the firm's costs or revenues in the previous year, and modified to take account of the risk profile of the firm. The basis for setting this requirement should be clearly defined, and would need to be sufficient to ensure that the condition for the well-managed firm was met such that

$$(\sigma_{t+1})k_w < Regulatory\ Capital_w < Optimal\ Capital_w.$$

However, in order to prevent the firm from exploiting this fixed capital requirement by changing its risk profile after the capital requirement was set, the firm would also be required to supplement its regulatory capital by a precommitment amount that should be sufficient to cover the amount that its risk profile changed during the reference period.

The advantage of this approach would be that it would be simple from the firm's perspective, it would require relatively little detailed assessment by the regulator of the firm's own internal models regime, and would not be conditional on the firm having modeled every material risk before it took effect. At the same time, it could have incentives built in, since the more confident the regulator was about the quality of the firm's internal controls the lower could R_{t+1} be set, while still leaving the regulator the ultimate authority to ensure that all firms were capitalised at a level sufficiently in excess of $(\sigma_{t+1})k$ to protect the overall system against the risk of extreme systemic events. From the perspective of the firms, the fact that additional capital was required at the level of changes in $(\sigma_{t+1})k$ and not based on a higher multiplier would ensure that the regulatory regime remained in line with the requirements of the internal risk pricing, so avoiding the risk of regulatory arbitrage arising from inappropriate capital rules.

VII. Conclusion

It is becoming increasingly clear that the regulatory capital requirements for both banks and securities firms are not appropriately aligned either with the risk that those firms are taking or with the way in which those firms manage their own risks in order to maximise shareholder value and optimise their capital structures. In this paper, we have argued that this process has two elements. Internal risk measures such as value at risk can be used by financial firms as a means of enhancing shareholder value by targeting directly the firmwide Sharpe Ratio rather than through the indirect mechanism of internal capital allocation. However, we argue that these measures of unexpected loss need to be supplemented by techniques such as scenario analysis when assessing the firm's potential exposure to stress loss and thus determining the firm's optimal capital structure.

In light of these considerations, we do not believe that any of the current proposed regulatory capital regimes, which we characterise as the regulatory ratio approach, internal models approach, and the precommitment approach, are consistent with this account of risk pricing and capital optimisation within firms. By contrast, we believe that our proposal for a base plus approach to regulatory capital would be consistent with both regulatory objectives and firms' own internal processes, and as such would provide a sound basis for a regulatory capital regime for financial firms in the twenty-first century.

APPENDIX: THE SCALE INDEPENDENCE OF THE SHARPE RATIO

1. Definitions:

   I Arbitrary Amount of Investment

   F Financing Amount of Investment I

   C Capital Allocated to Investment I

   Such that:

   $$I = F + C.$$

   (This is merely a restatement of an accounting fact that assets = liabilities.)

   Further:

   $Exp(P)$ Expected Profits from Investment I net of direct and allocated indirect costs before funding

   $Exp(P_{net})$ Expected Net Profits, that is, profits after funding costs

   $Exp(R)$ Expected Return (percent) on (arbitrary amount) Capital Allocated to Investment I,

   where:

   $$Exp(R) = \frac{Exp(P_{net})}{C}.$$

   Vol_P Volatility of Profits

   Vol_R Volatility of Return on Equity

   r_f the Default Free Interest Rate

   In its simplest form, the Sharpe Ratio is defined as the excess return of an investment over the standard deviation of the excess return. If we assume that interest rates are fixed over the time horizon of the investment, then the volatilities of returns and of excess returns are the same.

2. First Result:

   Many activities in banking effectively require little or no investment at the outset (if regulatory capital requirements are neglected for a moment), such as swaps and futures. For this reason, we choose to start with an absolute revenue-based Sharpe Ratio and extend it to a relative (percent) measure in a second step.

   The excess profits over the risk-free rate of interest for capital and after any refinancing costs are given by:

   $$Exp(P) - r_f F - r_f C,$$

   and the Sharpe Ratio therefore by

   $$\frac{Exp(P) - r_f F - r_f C}{Vol_P} = \frac{Exp(P) - r_f(F + C)}{Vol_P}$$

   $$= \frac{Exp(P) - r_f I}{Vol_P} = \frac{Exp(P_{net}) - r_f C}{Vol_P}.$$

   The Sharpe Ratio of the Expected Revenues is thus given by the profits net of the costs for full (that is, 100 percent) refinancing over the volatility of earnings.

3. Second Result:

   If return is measured as the ratio of absolute return to allocated capital (which can be an arbitrary amount), then the following result holds for volatilities:

   $$Vol(Return) = Vol\left(\frac{P}{C}\right) = \frac{1}{C}Vol(P).$$

   This simple result obviously guarantees that the Sharpe Ratio does not change its value since both the numerator and the denominator are scaled by the same amount. A closer examination of the above formula, however, gives some intuition for this result

   $$\frac{\frac{Exp(P) - r_f I}{C}}{Vol(R)} = \frac{\frac{Exp(P) - r_f I}{C}}{Vol\left(\frac{P}{C}\right)} = \frac{\frac{Exp(P)}{C} - r_f\left(\frac{F}{C} + 1\right)}{\frac{1}{C}Vol(P)}.$$

   Apart from the fact that the C cancels out, one can see that the higher the leverage the higher the expected return on the one hand, but the higher also the volatility of the returns, which leaves the Sharpe Ratio unchanged.

4. Conclusion:

   As long as the institution can refinance itself at approximately the risk-free rate, or its refinancing rate is indifferent to changes in volatility over the relevant range, the amount of capital that it allocates to the business will not affect its Sharpe Ratio. This can be seen by solving the Sharpe Ratio backwards for some (arbitrary) capital allocation C:

$$\frac{Exp(R)-r_f}{Vol(R)} = \frac{\frac{Exp(P_{net})}{C}-r_f}{Vol\left(\frac{P}{C}\right)} = \frac{\frac{Exp(P)}{C}-r_f\left(\frac{F}{C}+\frac{C}{C}\right)}{\frac{1}{C}Vol(P)}$$

$$= \frac{\frac{Exp(P)}{C}-r_f\frac{I}{C}}{\frac{1}{C}Vol(P)} = \frac{Exp(P)-r_f I}{Vol(P)}.$$

Of course, this whole relationship changes as soon as the marginal cost of funding becomes a function of the credit quality of the institution. In that case, the costs of funding become an increasing function of the volatility of the profits (or returns) and, as a consequence, the Sharpe Ratio drops.

It is for this reason that the absolute level of capital in banks is held at some multiple of the volatility of the earnings, since this ensures that the cost of funding at the margin remains independent of day-to-day changes in the risk profile of the firm.

Endnotes

The authors are grateful to Marcel Rohner of Swiss Bank Corporation for his contribution to the development of this paper and for providing the appendix.

1. This is borne out by the experience of the recent precommitment pilot study and by the value at risk returns provided by members of the Derivatives Policy Group in the United States to the Securities and Exchange Commission.

2. Strictly, we should denote our risk term as $E(\sigma_{t+1})_t$—that is, expected value at time t of the standard deviation of earnings at time $t+1$. For ease of notation, however, we adopt the term σ_{t+1} for the rest of this paper.

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Capital from an Insurance Company Perspective

Robert E. Lewis

This morning, I would like to give a few practical comments on capital adequacy from an insurance company perspective. In doing so, I will present two views on capital adequacy and capital allocation in the insurance industry. The first view is the regulatory perspective, that is, the motivations behind regulatory capital requirements in the insurance industry, the structure of those requirements, and the relationship between regulatory capital amounts and the actual risks facing insurance companies. The second view is an insurance company perspective, in particular, the approach taken by the American International Group (AIG) to determine adequate capital allocations for our various businesses and for the firm overall.

Regulatory Perspective

The regulatory perspective on capital adequacy was well summarized, in June 1996, by B.K. Atchinson, president of the National Association of Insurance Commissioners (NAIC):

> The most important duty of insurance commissioners is to help maintain the financial stability of the insurance industry—that is, to guard against insolvencies.... Among the greatest weapons against insolvency are the risk-based capital requirements.

In other words, the NAIC recognizes the important role that capital can play in preventing insolvencies and has implemented a set of risk-based capital requirements intended to address this concern.

Without going into the details of the calculations, the NAIC's risk-based capital requirements are intended to capture several forms of risk facing insurance companies. For life/health companies, these risks include:

- asset risk: the risk of default or a decline in the market value of assets;
- insurance risk: the risk that claims exceed expectations;
- interest risk: the risk of loss from changes in interest rates; and
- business risk: various risks arising from business operations, including guarantee fund assessments for the eventuality that one insurance company fails and others have to stand by with capital to assume some of those losses.

For property/casualty companies, the risks covered by the capital calculations are different, because the business is quite different. In brief, the risk-based capital calculations are intended to cover:

- asset risk: the risk of default or a decline in the market value of assets;
- credit risk: the risk of loss from unrecoverable reinsurance and other receivables;

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- underwriting risk: the risk of loss from pricing and reserving inadequacies; and
- off-balance-sheet risk: the risk of loss from factors such as contingencies or high business growth rates.

While the regulatory capital requirements are intended to cover a wide range of the risks facing insurance companies, the rules have a number of shortcomings. From a technical perspective, the calculations impose overly harsh capital requirements along several dimensions. For one, the calculations do not include covariance adjustments within risk groups, so the benefits of diversification of risks are not fully recognized. Further, the requirements impose undue penalties on affiliated investments, ceded reinsurance, and adequate reserving, as well as on affiliated foreign insurers. The NAIC's risk-based capital rules also have a number of shortcomings from a practical or operational perspective. In particular, the requirements are applied only to insurance firms in the United States; there is no international acceptance of these requirements and, therefore, no level playing field with regard to capital regulation. Even within the United States, not all states apply the NAIC guidelines. Finally, since the requirements do not cover the full range of risks facing insurance firms, supervisors typically expect insurers to maintain multiples of the minimum risk-based capital requirement.

Further, in practice, the requirements have not proven to provide either a good predictor of future insolvency or a consistent rating of relative financial strength among insurers. History has shown that only a small percentage of insolvent insurers failed the risk-based capital test prior to their insolvency. Conversely, of those insurers that fail the risk-based capital test, only a small percentage actually become insolvent. Thus, the risk-based capital rules provide a very noisy indicator of the actual financial strength of U.S. insurance companies. On the plus side, however, the rules have permitted supervisors to take prompt regulatory steps against insurers without court action.

Insurance Company Perspective

A number of factors are influencing insurers' views concerning capital adequacy in the current insurance industry environment. Overall, a shortage of capital is not a problem for most insurers operating today; indeed, in the view of many, there is overcapacity in the industry. However, current conditions in the insurance industry may not prevail in the future. Overcapacity has intensified competition in the market for insurance products, driving a loosening in underwriting standards. While combined ratios—a measure of an insurer's overall underwriting profitability—are improving, this improvement largely reflects a lack of "catastrophes" and the resulting surge of claims, rather than strong underwriting practices. In many cases, loss reserves are not increasing commensurate with premium growth and profitability is being driven by attractive financial market returns, rather than by core underwriting activities. These conditions suggest that capital adequacy may become more of an issue in the not-too-distant future.

In March 1994, these views were nicely summarized by Alan M. Levin of Standard and Poor's:

> Of course, a strong capital base is an important determinant, but without good business position and strategy, management acumen, liquidity and cash flow, favorable trends in key insurance markets, dependable reinsurance programs, and numerous other factors, a strong capital base can be rendered inadequate in an astonishingly short time.

As this quotation suggests, there are many sources of unexpected losses that can quickly erode an insurer's capital base. These include adverse claims development (as the result of one or more catastrophes or because general expectations of claims were understated); unrecognized concentrations of risk exposures in investments and credit extensions; unexpected market risk developments that adversely affect investment returns; and legal risks such as legislation requiring retroactive coverage of exposures.

Given these considerations and the general environment in the insurance industry today, AIG has developed a set of basic principles concerning our approach to capital adequacy and business strategy. To begin, capital must be sufficient to cover unexpected losses while maintaining AIG's credit rating. We feel that the credit rating, the best credit rating, is absolutely important for an insurance company to maintain soundness, to maintain credibility and confidence, and to be able to seek any opportunity that it finds profitable.

Further, the insurance business must return an underwriting profit, without consideration of returns from the investment portfolio, and underwriting decisions must be kept separate from investment decisions. We find "cash-flow underwriting," as the term is called in the industry, to be a disturbing situation where risks are written assuming discount rates that require an insurer to take financial risk in order to achieve a profit. In a similar vein, operating cash flow and liquidity must be adequate to insulate the corporation from the need to liquidate investments to cover expected claims and losses. Finally, reserves must be built consistent with the company's current underwriting risk profile.

Our approach to modeling capital adequacy reflects these basic principles. First, we begin with actuarial assessments of capital and reserve adequacy for our underwriting business. We then look at balance-sheet capital, make economic adjustments, and allocate the adjusted capital to profit centers throughout the corporation. Each profit center must meet a hurdle rate of return *without* benefit of investment income. In this way, we assess capital adequacy in relation to the basic underwriting business, without relying on investment returns. To assess investment and other forms of credit risk, we are installing a credit risk costing model. Finally, we are in the process of implementing a market risk measurement model to assess market risks in our insurance-related investments as well as in our financial services businesses.

One important aspect of risk modeling that deserves special attention is concentration risk. Diversification of businesses is key to providing stable earnings, reserving, and capital growth. Ideally, capital modeling would be done using full covariance matrices to assess the degree of diversification—or, conversely, the degree of concentration—in business activities and other risks. However, designing an approach that makes use of full covariance matrices is a complex undertaking. Instead, we plan to emphasize stress testing of correlation risks. In this way, we can assess the impact from adverse events on insurance, investment, liquidity, and financial services, and get a picture of the extent of concentration risk across our business activities.

In our firm, we try to stress test through scenarios that look at the correlation of insurance investments, market risks, and liquidity risks. For example, we might look at an eight-point Richter Scale earthquake in Tokyo, which our geologists tell us is a highly positively correlated event with a sizable earthquake in California. When we look at that scenario and at what could happen from an insurance company perspective, we look at the possibility that financial markets are disrupted or closed for a period of time. In this environment, companies have to react and respond, have the liquidity to be able to make the investment decisions, and not have to sell assets into a very disrupted market. At the same time, we want to have enough capital, and a strong enough credit rating, to be the corporation that we are today. These are the types of stress tests that we undertake, and judgment is a big component of the whole exercise.

Conclusion

This paper has provided a brief overview of the factors affecting capital adequacy in the insurance industry, both from the perspective of insurance regulators and an individual insurance company. The key idea is that we try to approach capital adequacy from the perspective of not only being able to play the game after adverse events have occurred, but being able to play the game the way we play it today. While risk modeling is an important part of this assessment, we use the modeling only with a very high degree of reason and discussion.

Thank you.

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Commentary

Masatoshi Okawa

In my understanding, the issue of internal capital allocation is usually referred to as the question of how to allocate the overall capital of a financial firm among individual business areas of the firm, taking into account the amount of risk incurred by each business area. Internal capital allocation is used as a basis to decide the pricing of individual transactions or to evaluate the performance of each business area by the management of a firm. In this sense, the establishment of risk measurement methodologies is usually regarded as a prerequisite for successful internal capital allocation, as seen in the most famous example in this area, RAROC of Bankers Trust. Another concrete example of internal capital allocation is outlined in the paper, "Capital Allocation and Bank Management Based on the Qualification of Credit Risk," by Kenji Nishiguchi, Hiroshi Kawai, and Takanori Sazaki, although that paper deals only with credit risk.

It seems to me, however, that this session's first paper, "Building a Coherent Risk Measurement and Capital Optimisation Model for Financial Firms," by Tim Shepheard-Walwyn and Robert Litterman, tackles the issue from a different angle, reflecting the fact that risk measurement methodologies are still developing rapidly. The paper emphasizes how to quantify overall optimal capital for financial firms rather than how to allocate overall capital among individual business areas of the firm. I will not repeat the contents of the paper in detail. But I would like to point out some of the most challenging ideas.

First, the paper focuses on a risk pricing methodology called shadow pricing, instead of the more traditional risk-based capital allocation methodology. The objective is to maximize the firmwide Sharpe ratio, which represents the relationship between risk and the returns of a firm. The authors advocate this approach because risk-based capital allocation techniques would run the risk of incentivizing inappropriate behavior by overcharging for the risks that are yet to be subject to effective measurement. Although such techniques seek to allocate the total capital to the risks that have been identified and quantified, the traditional risk-based capital allocation methodology may lead to overcharging for risk because it lacks a comprehensive risk-factor model. In addition, this risk pricing methodology allegedly has some technical merits compared with the risk-based capital allocation methodology. For one, it recognizes covariance effects and the potential for implementation on a sequential basis without the significant risk of creating perverse incentives. I am not quite sure whether these technical aspects could be verified or not, and am interested to hear

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comments on this point from the session's participants.

Second, the paper considers a model for an optimal regulatory capital regime called the base-plus approach, which could replace the existing fixed-ratio approach, internal models approach, or even the precommitment approach. Under the base-plus approach, regulators determine a fixed amount of capital as a base requirement for the firm. In addition, regulators permit the firm to adopt the precommitment approach or models-based approach to cover any increase in the firm's risk profile during the reference period by the "plus" amount of the regulatory capital. The base-plus approach could be regarded as a combination of the fixed-ratio approach and the internal models or precommitment approach; the authors argue that it has some of the merits of both approaches.

The new base-plus approach is conceptually very interesting. Practically speaking, however, calculating the plus amount using the internal models approach or the precommitment approach could present a problem, especially for regulators. The plus amount is added to the base amount set by regulators for the purpose of covering any increase in the firm's risk profile. This seems redundant, however, given the multiplication factor of "at least three" that has been introduced in the market risk capital requirement because of the same concerns about the theoretical limitations of internal models. Furthermore, the required amount of capital in the 1988 Basle Capital Accord is already expected to function as a cushion for unexpected events of default. I very much look forward to hearing comments about this aspect of the base-plus approach from supervisors.

The second paper, "Capital from an Insurance Company Perspective," by Robert Lewis, explains the regulatory capital regime surrounding insurance firms in the United States, taking into account the function of capital at these firms and their differences compared with other types of financial firms. I would like to make just one remark here. It is a matter of course that the function of capital differs between insurance companies and other types of financial firms; these firms maintain different portfolio structures and conduct different activities. Problems could arise when the capital of these different types of financial firms is treated together. I would like to point out that this February the Basle Committee, IOSCO, and IAIS each released several papers on the supervision of financial conglomerates that are the result of the activities of the Joint Forum—an organization of banking, securities, and insurance supervisors. These organizations are seeking comments from the outside world. One of the papers released this February deals with possible methodologies for calculating the groupwide capital of financial conglomerates, including insurance companies. In this area, the paper by Robert Lewis offers us some important insights.

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Session 6

The Role of Capital Regulation in Bank Supervision

Papers by

Arturo Estrella

Paul H. Kupiec and James M. O'Brien

Allen B. Frankel

Commentary by

Christine M. Cumming

Formulas or Supervision? Remarks on the Future of Regulatory Capital

Arturo Estrella

INTRODUCTION

How much capital should a bank have? There was a time, not too long ago, when the answer to this question seemed simple, at least to some. Then came floating exchange rates, oil shocks, global inflation, swaps, inverse floaters, and other tribulations, and the answer seemed not to be so simple after all. Regulators responded in kind with more complicated formulas; they introduced risk weights, credit-equivalent amounts, potential future exposures, maturity buckets, and disallowances. How does this story end, and what is the moral of the story? Were things ever really simple? Do we have more confidence now in the accuracy of the capital assessments?

We must bear in mind two important facts in order to address those questions. First, regulatory capital has never been a mindless game played with simple mechanical formulas. Second, firms themselves have used a changing array of prevailing practices to develop their own estimates of the level of capital they should have. To be sure, mistakes have been made, but those mistakes typically have not resulted from thoughtless reliance on mechanical formulas.

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This paper focuses on the relative emphasis that the structure of regulatory capital places on formulas and on supervision. The two are not viewed as mutually exclusive, but as elements to which capital policy implicitly assigns relative weights. We will see that in U.S. regulatory practice, these weights have shifted over time, not always in the same direction. Furthermore, we will explore the relationships among regulatory formulas, supervisory appraisals, and the prevailing business practices in the banking industry.[1] We then ask, what is the appropriate mix of formulas and supervision?

Why is this an important issue? Consider three related reasons. First, there is a risk of an increasing disconnect between regulatory capital and what banks and other financial institutions do. The last few decades have brought tremendous changes in the nature of financial firms, their activities, and their approaches to risk management. In such an environment, past regulatory achievements provide no guarantee of future success. Second, for much the same reasons, inertia will almost surely lead regulators down the wrong path. Steady progress in a given direction is not enough if the business has a tendency to change course—to innovate. Third, banks and other institutions are in danger of being over- or underregulated as the business changes course. Overregulation can thwart a useful economic role for financial institutions. Underregulation can undermine faith in the financial sector and dampen its role as a catalyst for economic progress.

The issues considered here are difficult and fundamental, and they seem resistant to an approach based solely on straightforward economic analysis. Therefore, this article makes use of a variety of tools: analytical, historical, doxographical. We examine the rationale for capital regulation; the history of regulatory capital in the United States, including current and proposed approaches to regulatory capital; and the expressed views of practitioners and theorists.

To preview the results, the principal conclusion is a reaffirmation of the benefits of informed supervision. Mechanical formulas may play a role in regulation, but they are in general incapable of providing a solution to the question of how much capital a bank should have. At the margin, scarce public resources are better employed to enhance supervision than to develop new formulas whose payoff may be largely illusory.

Assumptions of Regulatory Capital Policy

We examine in this section the basic reasoning that underlies regulatory capital as we observe it in practice. One conclusion to be drawn from the existing academic literature on this topic is that it is difficult to define—let alone compute—the right level of capital for an arbitrary institution.[2] In the end, the problem is so complicated and the technical tools so limited that reasonable persons may have substantial disagreements about the right amount of capital that a given firm should hold.

Since it is impossible to "prove" that there is any one right approach to regulatory capital, and since support for any approach must ultimately rest on some ungrounded propositions, I attempt here simply to list a series of assumptions that are likely to be representative of the thinking behind existing systems of regulatory capital. The structure provided by this inventory can then serve as a backdrop for the discussion of specific aspects of the regulatory capital framework.

Consider first some very general assumptions concerning the rationale for capital. These assumptions are relatively noncontroversial and are probably widely held.

1. Capital can help protect the safety and soundness of individual institutions.
2. Capital can help protect the safety and soundness of the financial system.
3. Supervisors can play a socially useful role by monitoring the capital levels of financial institutions.

Support for assumptions 1 and 2 may be found in Berger, Herring, and Szegö (1995) and in many of the references contained in that paper. Assumption 3 may be slightly less straightforward, particularly if an extreme "free market" point of view is adopted. Nevertheless, it seems likely that most observers would admit that the capital decisions of individual institutions may produce externalities and that an impartial public-sector supervisor with enforcement powers can play a useful monitoring role.

The following assumptions involve the appropriate levels of capital more directly, or the means of estimating such levels. Most of these assumptions are likely to have been maintained in the framing of capital requirements at one time or another.

4. There is some level of capital that is consistent with the interests of the firm and the regulatory and supervisory objectives of safety and soundness. Call this the optimum level of capital.
5. The optimum level of capital can be estimated with reasonable accuracy.
6. A lower bound for the optimum level of capital can be computed from a mechanical formula.
7. An accurate estimate of the optimum level of capital can be computed from a mechanical formula.

Assumption 4 strikes a balance between the objectives of the firm and those of regulators, which in general are not identical.[3] In assumptions 6 and 7, note that the term "mechanical formula" does not presuppose that the formula is simple, but only that it be computable in a mechanical way, for instance, by means of a computer program. Explicit regulatory capital requirements in the United States and in most other industrial countries are consistent with assumption 6. In fact, the 1988 Basle Accord (Basle Committee on Banking Supervision 1988) states that: "It should be stressed that the agreed framework is designed to establish *minimum* levels of capital for internationally active banks" (italics in original).

Assumption 7 is more controversial. The Basle Committee on Banking Supervision (1988), for example, is careful to point out that its measure is in no way optimal. The committee emphasizes "that capital adequacy as measured by the present framework, though important, is one of a number of factors to be taken into account when assessing the strength of banks." Of course, the fact that one specific formula is not sufficiently accurate does not rule out that other, more accurate formulas may exist.

If assumptions 1 through 7 all held, there would be a high degree of confidence in the well-functioning of regulatory capital. In fact, many of these assumptions are unlikely to be controversial. Most problematic are those assumptions that involve some knowledge of the optimum level of capital, perhaps obtained by means of a mechanical formula. I refrain at this point from taking a stand on the assumptions. In a later section, I return to the issue of whether optimum capital is calculable by means of mechanical formulas.

U.S. Regulatory Practice in Historical Perspective

A brief preliminary review of the history of regulatory capital for U.S. banks may provide a helpful perspective on the issue of the relative importance of formulas and supervision.[4] Before 1981, there were no explicit regulatory requirements for capital ratios. Examiners from the federal supervisory agencies (the Office of the Comptroller of the Currency, the Federal Deposit Insurance Corporation, and the Federal Reserve System) were responsible for formulating opinions about the capital adequacy of individual firms. Any formulas used differed from supervisor to supervisor, and possibly even from bank to bank, and were conceived as informal guidelines rather than as precise estimates of an optimum level of capital. In terms of the structure of the previous section, we could think of the pre-1981 regime as embodying the first five assumptions, but not the last two.

In 1981, in the aftermath of the thrift crisis and in the midst of widespread discontent with the actual capital ratios of many banking institutions, a new three-tier set of explicit capital requirements was introduced. These requirements were based on the ratio of primary capital, which consisted mainly of equity and loan loss reserves, to total assets. The multi-tier framework was instituted to facilitate the transition to the new system by larger institutions, whose capital ratios were in general less than desired. The distinctions among banks of different sizes were eliminated in 1985.[5] In this early period of explicit capital requirements, we could say that regulators and supervisors became more comfortable with assumption 6 regarding a lower bound for optimum capital.

Toward the mid-1980s, there was again some discontent with the levels of capital of U.S. institutions, and once again the focus tended to be on the larger firms. At the same time, regulators in other countries, including the United Kingdom and Japan, had similar concerns about their own institutions. These countries joined forces with others in the so-called Group of 10 and issued in 1988 the Basle Accord (Basle Committee on Banking Supervision 1988).[6]

The Accord differed in two significant respects from the structure of capital requirements then in place in the United States. First, for the purpose of calculating required capital, asset values were weighted by a few simple credit risk factors. Second, the risk-weighted assets were supplemented by credit-equivalent amounts corresponding to off-balance-sheet instruments. The 1988 innovations relied on the same assumptions 1 through 6 as the 1981 requirements. However, the changes reflected two new developments.

First, large firms were increasingly engaged in activities that produced risky exposures not captured (or not fully captured) on the balance sheet. This change exposed a natural weakness of mechanical formulas: they typically have to be adjusted when there are unforeseen changes in the environment. The second development was, in essence, increased confidence in assumption 6, that is, on the precision of formulas for calculating a lower bound for optimum capital. For example, factors corresponding to potential future exposure of off-balance-sheet instruments were based, albeit loosely, on state-of-the-art mathematical simulation methods.

The most recent event in our chronology is the introduction of market risk rules by the Basle Committee

(1996). The 1988 Basle Accord had recognized that there were various problems that were left unresolved for future iterations. The 1996 rules took the ground-breaking step of allowing banks to calculate their exposure to market risk using their own internal models, subject to some restrictions on the choices of parameters and features of the model.[7] As in 1988, these changes reflected increased confidence in assumptions 1 through 6, rather than the introduction of a new one. In 1996, the optimism centered on assumption 5—on the accuracy with which optimum capital could be estimated using state-of-the-art modeling techniques.

To summarize, history demonstrates that supervision and examination have always played a major role in regulatory capital in the United States, and that it is only since 1981 that mechanical formulas have been used explicitly across the board. Of the assumptions listed in the previous section, only assumption 7 failed to be invoked historically. However, through history, there has been a clear recurrent fascination with the idea of reducing everything to formulas, and it seems unlikely that such an ideal has been given up at this point. In the next section, I turn to assumption 7 or, more specifically, to the drawbacks of mechanical formulas and to their limitations in defining regulatory capital.

The Problems with Formulas

The landmark Basle Accord of 1988 was issued by the Basle Committee on Banking Supervision under the chairmanship of W.P. Cooke. The Accord relies heavily on mechanical formulas, but it is clear from the document that it by no means constitutes an unqualified endorsement of formulas. In fact, a few years earlier, Cooke (1981) had stated bluntly that "There is no objective basis for ex-cathedra statements about levels of capital. There can be no certainty, no dogma about capital adequacy." This section is an attempt to understand the limitations of mechanical formulas.

One could easily conceive of mechanical formulas playing a useful role in banking if the business were completely determined by formal laws that were clearly stated and strictly implemented. In the words of legal philosopher H.L.A. Hart (1994), "Everything could be known, and for everything, since it could be known, something could be done and specified in advance by rule. This would be a world fit for 'mechanical' jurisprudence." However, the reality of banking is quite different: the business has important informal determinants and conventions that have evolved over the course of several centuries and that continue to evolve.

Banking has developed in most countries as a market solution to a common array of business problems. Furthermore, not only is the institution of banking an evolving response to economic conditions, but evolving economic conditions are in turn profoundly affected by the institution of banking. These mutual influences are so important that it would be impossible, in the context of a mature banking sector, to identify one as logically or chronologically prior to the other.[8]

Fundamentally, banks and other financial firms are social institutions. They have emerged not by external design, but as sets of rules that rest on a social context of common activity. These rules are not limited to formal laws, like banking statutes and regulations, but also include conventions that are predicated on the agreement of the parties involved and on the existence of formal and informal criteria that may be used to determine whether the rules are being followed.[9]

Examples of informal rules abound in banking. There is remarkable consistency in the instruments that banks employ, even banks of different sizes and geographical locations. Consider, for example, commercial loans. There is some variation in the terms of these loans, such as maturity and reference interest rates, but the choices are typically conventional and essentially "menu-driven." Furthermore, even the criteria for loan approval are determined by the normal practices of the business. Other examples of conventional instruments are consumer loans, mortgages, demand deposits, and time deposits. Closer to the issue of regulatory capital are conventions with regard to risk management, such as simulation models for calculating exposures to fluctuations in market prices and, more generally, value-at-risk models. Consensus on these techniques, while not universal, is widespread.

The business practices of the financial sector, and in particular the network of informal rules and conventions on which they are partly based, provide a certain level of consistency, but they are also dynamic and complex. A supervisory or regulatory regime that ignores these practices will fail to deal with the economic reasons for the existence of the financial sector and, if the restrictions are binding or even relevant, the regime will create economic distortions and inefficiencies that will make everyone worse off. Consider in turn the implications of dynamism and complexity.

There is no question that the financial sector is dynamic. Commons ([1934] 1990) anticipated later observers in noting that "Working rules are continually changing in the history of an institution." And North (1990), drawing on historical observations, contends that "The stability of institutions in no way gainsays the fact that they are changing. From conventions, codes of conduct, and norms of behavior to statute law, and common law, and contracts between individuals, institutions are evolving and, therefore, are continually altering the choices available to us."

How can we rely on static formulas if they have to be applied to a business that is continually changing? Obviously, the only way to keep pace is to change the formulas. However, predictability in regulation is helpful, perhaps essential. What happens if, in an effort to keep up with the dynamism of banking, inflexible regulatory regimes have to be modified at an increasing pace? There is a tradeoff between predictability and dynamism, and there is a danger that changes are now (and will continue to be) required with increasing frequency.

Let us turn to the issue of complexity. The very fact that an activity is based on informal rules brings with it some degree of complexity. North (1990) contends that:

> It is much easier to describe and be precise about the formal rules that societies devise than to describe and be precise about the informal ways by which human beings have structured human interaction. But although they defy, for the most part, neat specification and it is extremely difficult to develop unambiguous tests of their significance, they are important.

To be sure, one of the reasons for the complexity of informal rules is that they have not been written down, or formalized. However, the problem is not simply that they have not been specified, but rather that they defy specification. Behind the network of routine practices of the business lurks a system of true inherent complexity.

So, where do we turn? A decision by the Supreme Court of the United States (1933) may be useful in providing some sense of direction.[10] In referring to the Sherman Anti-Trust Act of 1890, the Court stated that

> As a charter of freedom in the public interest, the act has a generality and adaptability comparable to that found to be desirable in constitutional provisions. It does not go into detailed definitions which might either work injury to legitimate enterprise or through particularization defeat its purposes by providing loopholes for escape. The restrictions the act imposes are not mechanical or artificial.

Abstracting from the specific legal issue facing the Court on that occasion, the general economic principles are close in spirit to those that we address here. The suggestions are clear: strive for generality and adaptability in statute and regulation, avoid detailed definitions that may be inefficient and circumventable, stay away from the mechanical or artificial.

Do we want to say, in conclusion, that there is no role for mechanical formulas in regulatory capital? No, that would be dogmatic and inflexible. Even if formulas are problematic as constraints on banks' decisions, they may still be useful in some circumstances, for instance, to convey certain kinds of information about the bank or to make some interbank comparisons. We do not want, however, to be unreasonably restrained by lingering mechanical formulas for years or decades at a time. It therefore seems advisable to avoid writing detailed mechanical formulas into statute and possibly even into regulation.

What Else Is There?

If mechanical formulas hold very little promise of identifying appropriate levels of regulatory capital, what else is there for regulators to turn to? In announcing the sweeping changes in financial regulation and supervision that took place in the United Kingdom in 1997, Sir Andrew Large (1997) indicated that "I don't think we should lose sight of the fact that so much in regulation is not about structure but about attitude and management: the 'how' of regulation; the way it is done." The implications for regulatory capital seem clear. It is an important priority of supervisors to determine whether the appropriate "attitude and management" toward capital prevail in a firm, to focus on the way things are done. It is less clear that they need to provide the firm with mechanical formulas to estimate the appropriate level of capital.

Yet mechanical formulas produce tangible results, whereas attitude and management seem quite fuzzy. If we were to rely less on formulas, is there any substitute for the determinacy they seem to provide, or are we inevitably thrust into an environment in which there are no guideposts and only discretion prevails? This is potentially a serious difficulty, certainly in practical terms, but especially in view of the arguable importance for authorities to commit in advance to certain types of behavior in order to avoid problems of moral hazard and time inconsistency.[11] However, in banking, there is a network of informal constraints—as described in the preceding section—that can provide a solid grounding for the capital decisions of firms and the informed judgment of supervisors.

These informal constraints or conventions are also useful in dealing with moral hazard and time consistency problems. Although formal economic models often imply that mechanical rules are necessary for those purposes, Williamson (1983) and North (1990), among others, conclude that conventions are sufficient to achieve "credible commitments" in real-world situations. A particularly relevant case is presented by North and Weingast (1989). They argue that, following the Glorious Revolution in seventeenth-century England, the Crown and Parliament agreed to abide by credible commitments that led to new institutional arrangements. These new institutions, in turn, made possible the development of modern financial markets.

The foregoing considerations suggest that, in designing regulatory capital requirements, it is desirable to avoid excessive detail in statute and regulation. However, to determine how much capital a bank should have, detail is ultimately unavoidable. One solution to this regulatory dilemma is to ensure both that firms delve into whatever level of detail is necessary and that supervisors have the necessary expertise to determine whether the details are properly handled by the firm. In terms of the initial question of this paper, less weight could be placed on the development of mechanical formulas, and more weight could be devoted to supervision.

We should note that, in this regard, there is no immediate cause for alarm. The principal concerns, however, are not with the present, but with the future evolution of the system. How do we make further progress, and how do we avoid allowing the dynamic environment to elude us?

Let us review a couple of recent ideas. First, consider the "pre-commitment approach," an attempt to do away with mechanical formulas for the calculation of capital for market risk and to replace them with penalties for firms whose decisions are proven wrong by experience.[12] Under this approach, firms pre-commit a certain amount of capital for market risk at the beginning of, say, each quarter. This amount may be determined by whatever means the firm sees fit. At the end of the quarter, the supervisor compares the firm's losses arising from market risk, if any, with the pre-committed amount. If the loss exceeds the amount, a penalty of some sort is imposed. Kupiec and O'Brien (1995b) consider a broad range of possible penalties, from monetary fines to supervisory disclosures.

The pre-commitment approach is attractive for several reasons. First, it provides considerable flexibility in the determination of capital amounts. Second, it is not intrusive; it is designed to allow the firm to pursue its business objectives with few distortionary effects from regulation. Third, it seems to require little knowledge or effort on the part of the supervisor. With regard to banks' internal models, Kupiec and O'Brien (1995a) argue that "It is virtually impossible for a regulator to verify the accuracy of the size of the losses associated with rare tail events." They propose instead the easier task of comparing actual losses with a pre-committed amount.

Though theoretically attractive, there are serious problems in the implementation of the pre-commitment approach. One central issue is the design of the penalty structure. The approach circumvents the need for mechanical formulas in the initial determination of capital, but regulators must address the need for a "penalty formula" at the other end. Should this be a mechanical formula, which might suffer from the shortcomings described in the previous section? Should there be room for supervisory discretion? Some proponents of the method might be put off by the introduction of discretion in a method conceived as objective and nondiscretionary. There are also other, more mundane issues, such as defining what is meant by "the firm's losses arising from market risk." Thus, the pre-commitment approach is basically attractive, but is not without its share of practical problems.

Another idea from the recent literature is what we might call the "supervisory approach," whose rationale is to focus primarily on the determination of optimum capital by the firm, monitored by the supervisor, while limiting reliance on mechanical formulas to a simple, well-defined role in which they are more likely to be useful.[13] Under this approach, the firm would be accountable in the first instance for determining its own appropriate level of capital, abiding by sound practices developed in the context of the business. Firms engaged in trading of complex financial instruments, for example, would need to apply sophisticated mathematical techniques, which they would be required by supervisors to have at any rate for risk management purposes. Firms that focus on small business lending would have to apply very different techniques, most likely emphasizing more traditional credit analysis.

The supervisor would monitor the performance of the firm in the determination of the appropriate level of capital. There is substantial potential synergy between the supervisory review of risk management activities, which is already an important part of bank examinations, and the monitoring of regulatory capital in the way described. Furthermore, the attention paid by supervisors to the process, not just to the final result, provides incentives for firms to refine their management of risk. In monitoring the determination of capital, the supervisors would also ensure that the views of the firm are consistent with the public goals of systemic safety and soundness, and that there is no attempt to take undue advantage of elements of the financial safety net, such as deposit insurance. Procedures to enforce compliance through supervisory sanctions would have to be in place, much as they are now in the United States and other countries.

Finally, mechanical formulas could be retained in a relatively modest role as rough indicators of severely inadequate capital. If an institution were to require closure, it is in the public interest to prevent any losses from having to be borne ultimately by taxpayers. A formula may be helpful in this regard as a trigger point, much in the same way that prompt corrective action regulation is implemented for U.S. banks.

One important issue in the supervisory approach is that it places a substantial burden both on firms and supervisors. Firms have to be ready to take the necessary steps to make an accurate assessment of their need for capital. For many of them, reliance on mechanical formulas would not be an option. Supervisors would have to develop and retain human and other resources that would enable them to come to grips with the full diversity of methods employed by firms.

The supervisory approach is in many ways similar to the system in place in the United States prior to 1981, which regulators in the end found unsatisfactory. However, the similarities are only superficial, because a broad array of new conventions has been introduced in the financial markets since 1981. For instance, in the 1970s, many financial institutions were caught off guard by sudden bursts of inflation and sharp rises in interest rates, and the magnitude of the resulting losses was staggering. Today, even the smallest institutions are aware of interest rate risk and are required by supervisors to manage it prudently. In general, firms and regulators are much more cognizant today of risk and risk management, and this awareness has led to a whole structure of conventions designed to deal flexibly with new risks as they are identified.

The approaches to regulatory capital described above are only two examples of methods that can help effect a shift from mechanical formulas to supervision in the context of regulatory capital. As these and other potential ideas are discussed, what criteria can be used to evaluate them? Toward this goal, we conclude with the following series of questions, which are based on the analysis of this paper.

- Does the idea make sense in principle? Does it address the shortcomings of the current system and is it based on sound theoretical analysis?
- What are the practical implications of implementation? What exactly is required on the part of the institution and on the part of supervisors?
- Is it a short-term fix or a long-term solution? Is it capable of handling new instruments and practices?
- Is it applicable to the institution as a whole? Would other different—and potentially inconsistent—approaches have to be developed for other risks or other parts of the business?

ENDNOTES

1. Although most of the discussion of this paper focuses on banks, the principles delineated also apply to other types of financial institutions that perform similar services. The focus on banks is adopted to make the analysis more concrete, especially since history is one of the main tools employed in the paper. For similar reasons, examples are drawn mostly from the U.S. experience.

2. For example, see Berger, Herring, and Szegö (1995) and Dewatripont and Tirole (1994). Historical approaches to banking crises include Bernanke (1983) and Mishkin (1991), whereas Davis (1992) and Calomiris and Gorton (1991) combine theoretical and historical analysis.

3. The Modigliani-Miller (1958) theorem implies that under certain ideal conditions, the firm would not have a preference for any determinate level of capital. However, see also Berger, Herring, and Szegö (1995), and Miller (1995).

4. See Gaske (1995), Berger, Herring, and Szegö (1995), and Kaufman (1991).

5. Board of Governors of the Federal Reserve System (1985).

6. An account of the process that led to the Basle Accord is found in Bardos (1987-88).

7. The model-based rules are described in detail in Hendricks and Hirtle (1997).

8. An interesting attempt to model these types of mutual influences is found in Caplin and Nalebuff (1997).

9. In this paper, the terms "rules," "formulas," and "models" have very different meanings, as the usage in the text demonstrates. Rules are interpreted quite generally to include conventions and other practices that are generally followed in the course of business but are not formally prescribed, for example, by statute or regulation. Mechanical formulas include mathematical expressions, but more generally any formula that can be constructed, for example, by means of a computer program and therefore that can be computed without human judgment or intervention. Finally, models refers to mathematical techniques applied to a specific problem, say, to the estimation of optimum capital for a given bank. These models may include, among others, value-at-risk models for calculating market risk of trading portfolios.

10. I am grateful to Arturo Estrella, Sr., for this reference.

11. See, for example, Kydland and Prescott (1977).

12. See Kupiec and O'Brien (1995b).

13. Some thoughts on how a regulatory approach could be designed are found in Estrella (1995).

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Deposit Insurance, Bank Incentives, and the Design of Regulatory Policy

Paul H. Kupiec and James M. O'Brien

1. Introduction

A large literature studies bank regulatory policies intended to control moral hazard problems associated with deposit insurance and optimal regulatory design. Much of the analysis has focused on uniform bank capital requirements, risk-based capital requirements, risk-based or fairly priced insurance premium rates, narrow banking, and, more recently, incentive-compatible designs.

All formal analyses employ highly simplified treatments of an individual bank or banking system. This study is concerned with the appropriateness of modeling simplifications used to characterize banks' investment opportunity sets and access to equity financing. While the characteristics of assumed investment opportunities differ among studies, all are highly simplified relative to the actual opportunities available to banks. In some studies, banks are assumed to invest only in 0 net present value (NPV) market-traded securities while in other studies only in risky nontraded loans. In models where banks make risky nontraded loans, loan opportunity set characteristics are highly specialized. Frequently, a bank is limited to choosing between a high- and a low-risk asset. In both these cases and those in which loan opportunity sets are expanded, a well-defined relationship between risk and NPV is assumed. Further, in many analyses, banks are assumed to have unrestricted access to equity capital at the risk-free rate on a risk-adjusted basis.

In the full version of this paper (Kupiec and O'Brien [1998]), we show that these modeling specializations have been important for policy results frequently cited in the literature. The shorter version presented here is limited to showing that substantial difficulties in optimal regulatory design arise when greater complexity in bank investment opportunity sets and financing alternatives is recognized.

For the analysis, banks are assumed to maximize net shareholder value, which derives from the banks' "economic value-added" and the net value to shareholders of deposit insurance. Economic value-added comes from positive net present value loan investments and from providing liquidity or transaction services associated with deposit issuance. A bank's economic value-added is measured net of dead-weight costs associated with outside equity financing (equity issuance costs) and the present value of potential distress costs. The latter costs are incurred when outside capital is raised by the bank against its franchise value to cover a current account deficit. In contrast to previous

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models of bank regulation where loan investments are assumed to satisfy a well-defined investment opportunity locus—such as first-or second-order stochastic dominance—different loan NPV and risk configurations are permitted here.[1] Even if a bank's optimal loan choices can be limited to a subset of all its loan investment opportunities, this set will depend on the regulatory regime. Also, in determining its risk exposure, the bank has access to risk-free and risky 0 NPV market-traded securities.

Because deposit insurance can create moral hazard incentives, share value maximization need not coincide with maximization of the bank's economic value-added. In our model, the objective of regulatory policy is to minimize reductions in banks' economic value-added due to moral hazard influences on bank investment and financing decisions. Besides the determinants of economic value-added described above (that directly enter shareholder net values), optimal regulatory design must also factor in the dead-weight costs incurred in closing an insolvent bank.

If, as assumed in previous models of bank regulation, the bank has unrestricted access to equity capital at the risk-free rate on a risk-adjusted basis, the moral hazard problem associated with deposit insurance in these models can be resolved by requiring full collateralization of insured deposits with the risk-free asset and setting the insurance premium at zero. Since equity financing is avaliable at the risk-free rate on a risk-adjusted basis, the bank will want to undertake all positive NPV loan investment opportunities and deposit issuance will be governed by the profitableness of providing deposit transaction services.

The optimal design of regulatory policy becomes much more complicated when it is recognized that outside equity financing can be costly, that is, all-in issuance costs may significantly exceed the risk-free rate on a risk-adjusted basis. When equity issuance is costly, regulatory schemes that require the bank to raise a lot of equity capital, including narrow banking, can impose significant dead-weight costs on bank shareholders and discourage positive NPV investments. Under costly equity issuance, an optimal bank capital requirement that most efficiently resolves moral hazard incentives will be tailored to each bank's investment (risk and NPV) opportunities and its access to capital financing. The optimal bank-specific capital requirements and insurance premium rates, however, are difficult to achieve because regulators must have information on banks' investment choices or opportunity sets on the level of a bank insider.

Incentive-compatible regulatory mechanisms have been proposed as a way of solving the information problems that regulators face in designing an optimal policy.[2] However, when bank investment opportunities are more complex than typically assumed, we find substantial limitations on the incentive-correcting or sorting potential of incentive-compatible proposals. Our results suggest that incentive approaches that are able to achieve optimal bank-specific results, even if possible, require extensive information gathering. More likely, feasible regulatory alternatives will be much less information-intensive and, even when usefully employing incentives, will be uneven in their effectiveness and decidedly suboptimal on an individual bank basis.

2. Bank Shareholder Value and Economic Value

2.1. Model Assumptions

Each bank makes investment and financing decisions in the initial period to maximize the net present value of shareholders' claims on bank cash flows realized in the next period. On the asset side, a bank may invest in one-period risky nontraded loans, risky 0 NPV market-traded securities, and a 0 NPV risk-free security.

Individual loans are discrete investments and a bank's loan investment opportunity set is defined to be the set of all possible combinations of the discrete lending opportunities it faces. Each loan has an associated investment requirement, NPV, and set of risk characteristics. While financial market equilibrium (absence of arbitrage) requires that the expected returns on traded assets be linearly related to their priced risk components, this condition places no restrictions on the relationship between the NPV and risk of nontraded assets. Assets with positive NPV are expected to return to bank shareholders more than their market equilibrium required rates of return. For such assets, there are no equilibrium conditions that impose a relationship among NPV, investment size, or risk. Thus, a bank's loan investment opportunity set could be characterized by a wide variety of investment size, loan portfolio NPV, and risk combinations. Any subset of investment portfolios that a bank may choose to restrict itself to will depend on the regulatory policy regime.

The bank finances its investments in loans (L), risky securities (M), and the risk-free asset (T) with a combination of internal equity capital, external equity, and deposits. End-of-period deposit values (B) are government insured against default. Internal equity (W) represents the contribution of the initial shareholders. Outside equity financing (E) generates issuance costs of $d_0 \geq 0$ per dollar of equity issued. While deposit accounts provide transactions or liquidity services, the model treats these accounts as equivalent to one-period discount bonds. Deposits earn the one-period risk-free return of r, less a charge for liquidity services that earns the bank a profit of π per dollar of deposits. Both these profits and the bank's deposit insurance premium payments, denoted by $\phi B e^{-r}$, are paid at the beginning of the period. The bank has a maximum deposit base of $\bar{B}$ (par value).

In the second period, the bank's cash flows from its loans, risky securities, and risk-free bonds are used to pay off depositors. Shareholders receive any excess cash flows and obtain rights to a fixed franchise value, J.[3] If cash flow is insufficient to meet depositors' claims, the bank may issue equity against its franchise value. However, equity issued against J to finance end-of-period cash flow shortfalls generates "distress issuance costs" of $d_1 \geq 0$ per dollar of equity issuance. As with equity sales in nondistress periods, distress issuance costs would include both transaction fees and costs for certifying the value of the issue. The deposit insurer assumes the bank if it cannot cover its existing deposit liabilities.

2.2. Bank Shareholder Value

Under these assumptions, the net present value of initial shareholders' claims is given by

$$(1) \quad S = j_{L0} - I + e^{-r} J + \pi B e^{-r} + P_I - \phi B e^{-r} - \frac{d_1}{1-d_1}(P_D - P_I) - \frac{d_0}{1-d_0} E,$$

where

$$E = max\{(I + T + M + \phi B e^{-r} - (1+\pi) B e^{-r} - W), 0\}$$

and $I = \sum_{\forall j \in L} I_j$, $j_{L0} = \sum_{\forall j \in L} jL_j 0$.

The components of shareholder value follow: j_{L0} is the value of the loan portfolio, I its required initial investment, and $j_{L0} - I$ the loan portfolio's net present value; $e^{-r}J$ is the present value of the bank's end-of-period franchise value; $Be^{-r}\pi$ are the profits from deposit-generated fee income; $P_I - \phi B e^{-r}$ is the net value of deposit insurance to bank shareholders. P_I has a value equivalent to that of a European put option written on the bank's total asset portfolio with a strike price of $j_d = B - Te^{r} - (1-d_1)J$. This strike price is the cash flow value below which the bank's shareholders default on the bank's deposit liabilities. For $j_d \leq 0$, $P_I \equiv 0$.

The second line in equation 1 captures the costs associated with outside equity issuance. E covers any financing gap that remains after deposits, inside equity, and deposit profits net of the insurance premium, $(\pi - \phi)Be^{-r}$, are exhausted by the bank's investments. Each dollar of external finance generates d_0 in issuance costs, requiring that $\frac{1}{1-d_0}$ dollars of outside equity be raised. $\frac{d_1}{1-d_1}(P_D - P_I)$ is the initial value of the contingent liability generated by end-of-period distress costs. The distress costs are proportional to the difference between two simple put options, P_D and P_I, where both options are defined on the underlying value of the bank's asset portfolio. P_D is the value of a put option with a strike price of $j_{ds} = B - Te^{-r}$, the threshold value below which the bank must raise outside equity to avoid default. The strike prices of these options define the range of cash-flow realizations, (j_d, j_{ds}), within which shareholders bear financial distress costs.[4] Distress costs reduce shareholder value since $P_D \geq P_I$.[5]

2.3. Shareholder Value Maximization

The shareholder value function, S, must be maximized using integer programming methods. This is necessitated by the assumption that loans are discrete nontradeable investments with individualized risk and return characteristics.

Let j_{L_k0} represent the risk-adjusted present value of loan portfolio k that can be formed from the bank's loan investment opportunity set. The loan portfolio has a required investment of I_k and an NPV equal to $jL_k0 - I_k$. The bank shareholder maximization problem can be written as,

$$(2)\, maxS = e^{-r}J + \underset{\forall k}{max} \left\{ (j_{L_k0} - I_k) + max\left\{ K(L_j)\Big|_{L_j - L_k} \right\}\right\},$$

where

$$K(L_j) \;=\; P_I + (\pi - \phi)Be^{-r} - \frac{d_0}{1-d_0}E - \frac{d_1}{1-d_1}(P_D - P_I)$$

and $K(L_j)\big|_{L_j = L_k}$ indicates that the function K is to be evaluated conditional on the loan portfolio L_k. The conditional value of K is maximized over T, M, B, W, and the risk characteristics of the market-traded securities portfolio with E satisfying the financing constraint in equation 2, $B \in (0, \overline{B})$ and $I, T, M, W, E \geq 0$. Thus, for each possible loan portfolio (including the 0 investment loan portfolio), the bank maximizes the portfolio's associated K value by making the appropriate investment choices for risk-free and risky securities, outside equity issuance, and inside capital (or dividend payout policy). The bank then chooses the loan portfolio for which the *sum* of loan portfolio NPV and associated maximum K value is the greatest.

2.4. Bank Economic Value-Added

For analyzing the efficiency of alternative regulatory environments, we define a measure of the bank's economic value-added. As a simplification, the bank is assumed to capture entirely the economic value-added from its investment and deposit activities. That is, the bank's profits from deposit taking mirror the depositor welfare gains generated by transaction accounts, and the bank's asset portfolio NPV reflects the entire NPV produced by its investment activities. This avoids modeling the production functions, utility functions, and bargaining positions of the bank's counterparties when constructing a measure of social welfare. The bank's franchise value, J, is assumed to reflect entirely economic value-added (the future NPV of lending opportunities, providing deposit liquidity services, with no net insurance value).[6]

Netted against these economic value-added components are the bank's dead-weight equity issuance costs and distress costs, and the dead-weight costs borne by the insurer if the bank is closed. Under insolvency, the insurer pays off depositors with the realized cash flow from the bank's investments, the sale of the bank's franchise, and a drawdown on its cash reserve from accumulated premium payments. Dead-weight closure costs arise if, in disposing of the bank's franchise, the insurer loses a fraction of the initial value J. While the magnitude of such losses is unclear in practice, the simplest approach is to assume this fraction is the same as that lost by shareholders in a distress situation, d_1.[7] Under this assumption, the insurer's dead-weight closure costs are d_1J. Aggregating across all of the bank's claimants the realized end-of-period payments (payouts), taking their risk-adjusted present expected values, and subtracting initial investment outlays yield the bank's economic value-added. Where closure costs are equal to d_1J, the bank's economic value-added (EVA) is,

$$(3)\; EVA = j_{L0} - I + \pi Be^{-r} + Je^{r} - \frac{d_0}{1-d_0}E - \frac{d_1}{1-d_1}(P_D - P_I).$$

Because of the influence of deposit insurance on bank investment and financing choices, bank policies that maximize the net value of shareholder equity may not maximize the banks' EVAs. In the present analysis, an optimal regulatory policy consists of an insurance pricing rule and supplemental regulations, that is, capital requirements, that minimize the distortive incentive effects of deposit insurance, taking into account the direct effects on EVAs of the regulatory policy as well. The insurer or regulator is constrained to providing deposit insurance to an ongoing bank without subsidy, which is always possible in our model (see below).

3. Optimal Regulatory Policy When Equity Issuance Is Costless

First, consider the possibility of fairly priced insurance when the bank has perfect access to equity capital financing, that is, there are no equity issuance costs ($d_0 = 0$). The insurance is said to be fairly priced if the insurance premium is equal to the value of deposit insurance to bank shareholders, that is, $\phi B e^{-r} = P_I$.[8] Under a fair-pricing condition, no equity issuance costs, and access to a risk-free 0 NPV investment, net shareholder value is maximized by choosing all positive NPV loans and accepting all insured deposits. Any funding requirements in excess of the bank's internal equity capital and deposits can be costlessly met with outside equity financing. If there are potential distress costs ($d_1 > 0$), these can be costlessly eliminated by investing in the risk-free asset, as well as investing in positive NPV loans.

Further, when an intermediary can guarantee its deposit obligations by collateralizing them with risk-free bonds, if outside equity issuance is costless, the potential for costless collateralization creates the possibility of implementing fairly priced deposit insurance without any governmental subsidy to the banking system. This possibility is formalized in Proposition 1.

Proposition 1 *If (i) initial equity issuance is costless ($d_0 = 0$) and (ii) the bank has unrestricted access to risk-free bond investments, then a bank is indifferent between: (a) fairly priced deposit insurance and (b) a requirement that all insured deposits be collateralized with risk-free bond investments with an insurance premium equal to 0.*

Proposition 1 establishes the possibility of an efficient, fairly priced deposit insurance system in the form of a "narrow bank" deposit collateralization requirement. This proposition does not depend on banks earning deposit rents and would hold in a competitive equilibrium. Proposition 1 does require, however, that banks can issue equity at competitive risk-adjusted rates with no costs or discounts generated, for example, by informational problems or tax laws.

4. Regulatory Policy When Equity Issuance Is Costly

When it is costly to issue outside equity (the likely situation), a narrow banking requirement can generate significant social costs in the form of equity issuance costs and the opportunity cost of positive NPV investments that go unfunded. However, absent a narrow bank policy, pricing the deposit insurance guarantee is fraught with difficulties. One difficultly is that the bank regulators are unlikely to have sufficient expertise to value the bank's (nontraded) assets or assess their risk.[9] Even if regulators have sufficient expertise, the bank has an incentive to disguise high-risk investments or substitute into high-risk assets after its insurance premium has been set. Without resorting to highly intrusive monitoring, the moral hazard problem necessitates capital or other regulations that reduce risk-taking incentives arising from the deposit guarantee. The analysis here assumes that the insurer has the expertise to value individual assets banks might acquire and examines capital-based regulatory policies intended to solve the moral hazard problem.

To facilitate the analysis, we consider a hypothetical banking system comprised of four independent banks. Each bank faces a unique loan investment opportunity set

Table 1
ALTERNATIVE LOAN OPPORTUNITY SETS

Loan Number	Loan Amount	Expected Return[a]	Systematic (Priced) Risk[b]	Nonsystematic Risk[c]	Total Risk[d]	NPV[e]
Loan Opportunity Set A						
1	75	.20	.08	.20	.22	5.44
2	50	.10	.00	.45	.45	2.56
3	100	.25	.10	.30	.32	10.52
Loan Opportunity Set B						
1	75	.30	.10	.50	.51	12.14
2	140	.12	.05	.20	.21	2.83
3	50	.20	.10	.60	.61	2.56
Loan Opportunity Set C						
1	75	.20	.10	.45	.46	3.85
2	100	.03	-.10	.35	.36	8.33
3	50	.21	.12	.45	.47	2.04
Loan Opportunity Set D						
1	190	.21	.05	.10	.11	21.30
2	190	.75	.70	.90	1.14	0.00
3	50	.21	.12	.45	.47	2.04
Risky Market-Traded Security						
		.35	.30	.30	.42	.00

[a] One-period expected return to loan i defined by $\mu_i + .5\sigma_i^2$. See endnote 10.

[b] One-period systematic risk (standard deviation) for loan i, s_{0i}.

[c] One-period nonsystematic (idiosyncratic) risk for loan i, s_{1i}.

[d] Total risk for loan i (one-period return standard deviation), $\sigma_i = (s_{0i}^2 + s_{1i}^2)^{½}$.

[e] NPV is calculated using the expression in endnote 10, where the market price of systematic risk is 1, $\lambda = 1$, and $r = .05$ is the risk-free rate.

consisting of three possible loans (seven possible loan combinations). For simplicity, individual loans have log-normal end-of-period payoffs that include a single systematic (priced) risk source and an idiosyncratic risk.[10] Banks' individual loan opportunity sets are described in Table 1. Bank A's opportunity set includes loans with relatively modest overall risk. Bank B can invest in two loans with relatively high risk, one of which has substantial NPV. Bank C's opportunities also include relatively high-risk loans; its most profitable loan has negative systematic risk. Bank D's investment opportunity set includes a large, low-risk, high-NPV loan and a large, high-risk, 0 NPV loan. All four banks can invest in a risk-free bond and a risky 0 NPV security whose characteristics are described in the last row of Table 1. For simplicity, all heterogeneity across banks is assumed to arise from differences in loan investment opportunities. The three banks are subject to identical equity issuance costs ($d_0 = .2$), distress costs ($d_1 = .4$), franchise values ($J = 40$), maximum internal equity capital ($W = 27$), maximum deposits ($\bar{B} = 200$), and a common transaction service profit rate ($\pi = 0.025$). The risk-free rate is arbitrarily set at .05.

4.1. The First-Best Solution

To establish an optimal benchmark, assume that the insurer has sufficient knowledge to set a fair insurance premium and that the bank must irrevocably commit to its asset portfolio and capital structure before the insurer sets its premium. Table 2 reports each bank's optimization results.[11] Columns 2-6 report optimal loan, securities, and equity financing choices. Net share value is defined in equation 1 above. Economic value-added is the bank's net social value and is defined assuming that insurer closure costs mirror bank distress costs (equation 3). Net insurance value, $P_I - \phi B e^{-r}$, is zero by construction. For the risk capital ratio, capital is defined as the book value of loans and securities minus deposits, and risk assets are defined as the book value of loans plus risky securities. Under the closure cost assumption, if deposit insurance is fairly priced, $S = EVA$, and maximizing net share value also maximizes economic value-added. By this measure, fairly priced deposit insurance is a first-best policy with no need for capital requirements.

Implementing a fairly priced deposit insurance system is problematic when a bank's decisions cannot be completely and continuously monitored. Although each bank's insurance premium may be calibrated to fair value by assuming a bank operating policy that achieves maximum economic value-added, given this premium and an ability to alter its asset mix, a bank may face incentives to substitute into a more risky asset portfolio. In the example in Table 2, banks B and D could increase their insurance values, and net shareholder values, if they could substitute into higher risk assets at the given insurance rates (reported in footnote a). The insurance would become underpriced and, while shareholder values would increase, economic value-added would be reduced.

4.2. Optimal Policy with Imperfect Monitoring

Absent complete information on each bank's investments, deposit insurance can still be fairly priced and moral hazard incentives removed by imposing a narrow banking require-

Table 2
FAIRLY PRICED INSURANCE WITH PERFECT MONITORING
Bank Optimizing Results

Bank	Loans	Risky Security	Riskless Security	Internal Equity	Outside Equity	Net Share Value	Economic Value-Added	Net Insurance Value[a]	Risk Capital Ratio[b]
A	1, 2, 3	0.00	0.00	27.00	3.47	59.33	59.33	0.00	.154
B	1, 2	0.00	5.26	27.00	0.00	55.35	55.35	0.00	.140
C	1, 2, 3	0.00	0.00	27.00	4.57	53.58	53.58	0.00	.154
D	1	0.00	32.00	27.00	0.00	64.08	64.08	0.00	.167
							232.34		

[a] $P_I - \phi B e^{-r}$. For banks A, B, C, and D, the fair premium rates are .002, .008, .009, and 0, respectively.

[b] Book capital to risk assets. Book capital equals investments in loans and securities minus deposits. Risk assets equal loans plus risky securities.

ment that all deposits be collateralized with the risk-free asset. While feasible, the narrow banking solution can entail large reductions in banks' EVAs due to equity issuance costs and foregone positive NPV loan opportunities for which financing costs are now too high (see Kupiec and O'Brien [1998] for numerical illustration). However, if the regulator has complete information about each bank's investment opportunities and can enforce a minimum capital requirement, moral hazard incentives can be eliminated and fair insurance premiums can be set at a smaller social cost than is incurred under narrow banking. In determining optimal minimum capital requirements, the regulator must determine the minimum capital requirement and insurance premium rate combination that maximizes each bank's economic value-added, subject to a fair-pricing condition and incentive-compatible condition that the bank have no incentive to engage in asset substitution at its required capital and insurance premium settings.[12] The optimal capital requirement will vary with each bank's investment opportunity set.

The optimal bank-specific capital requirements are calculated for each bank in Table 3. The second and third columns in the table present bank-specific minimum capital requirements and fair-premium rates for the four banks. The fourth column shows the maximum economic value-added for each bank and, for comparison, the fifth column shows the first-best economic value-added reported in Table 2. The minimum capital requirements remove the moral hazard incentives for banks B and D that would exist at first-best capital requirements and premium rates. The costs of imposing the capital requirements are a small reduction in bank B's EVA due to a reduced loan portfolio NPV and equity issuance costs incurred by bank D. In general, the incentive-compatibility constraints required when the regulator cannot perfectly monitor bank actions will result in an optimal policy that is not a first-best solution.

Notice that the optimal bank-specific capital requirements are not "risk-based" capital requirements as defined under current bank capital regulations but are designed to solve the moral hazard problems. The insurance premium rates, being fair premiums, are risk-based. This is a more efficient solution than "risk-based" capital requirements with a fixed deposit insurance rate. Also note that the costs associated with a minimum risk-asset capital standard do not include a loss in the value of "liquidity services." Because the capital requirement applies to risk assets defined to exclude an identifiable risk-free asset (such as Treasury bills), there is no incentive for banks to reduce deposit levels. This result contrasts with studies that suggest an important cost of more stringent capital requirements is a reduction in the provision of socially valuable liquidity services (for example, John, John, and Senbet [1991]; Campbell, Chan, and Marino [1992]; and Giammarino, Lewis, and Sappington [1993]).

4.3. Imperfect Monitoring and Incomplete Information

The design of an optimal bank-specific capital policy imposes the unrealistic requirement that the regulator know each bank's investment opportunity set. A growing literature has proposed the use of incentive-compatible

Table 3

Optimal Bank-Specific Capital Requirements and Fair Insurance Rates without Perfect Monitoring

Bank	Required Risk-Capital Ratio	Premium Rate	Economic Value-Added	First-Best Economic Value-Added[a]	Net Insurance Value
A[b]	≥ .154	.002	59.33	59.33	0.00
B	≥ .247	.005	55.30	55.35	0.00
C[c]	≥ .154	.009	53.58	53.58	0.00
D	≥ .351	.000	55.36	64.08	0.00
			223.57	232.34	

[a] Figures taken from Table 2.

[b] Bank A's optimal strategy for any minimum required risk-capital ratio between 0 and .154.

[c] Bank C's optimal strategy for any minimum required risk-capital ratio between .045 and .154.

contracting mechanisms that can simultaneously identify the investment opportunity sets specific to individual banks and control moral hazard behavior even when the regulator is not fully informed a priori. Among others, Kim and Santomero (1988a); John, John, and Senbet (1991); Chan, Greenbaum, and Thakor (1992); Campbell, Chan, and Marino (1992); Giammarino, Lewis, and Sappington (1993); and John, Saunders, and Senbet (1995) provide formal analyses of incentive-compatible policies.

In the spirit of this approach, assume as before that there are four banks each with a loan investment opportunity set that is one of the types presented in Table 1, either A, B, C, or D. While an individual bank knows its type, the regulator only knows the characteristics of the alternative investment opportunity sets but does not know the opportunity set associated with each individual bank. Because it cannot distinguish bank types, the regulator cannot directly set the bank-specific capital requirements and insurance premiums that achieve the results in Table 3, that is, that solve the policy problem when the regulator has complete information on investment opportunity sets. The incentive-compatible literature suggests, however, that the risk types can be identified by an appropriate set of contracts.

Consider, as in Chan, Greenbaum, and Thakor (1992), an ex ante incentive-compatible policy based on a menu of contracts whose terms consist of combinations of a required minimum capital ratio and insurance premium rate, assuming the regulator can enforce a minimum capital requirement. As in the preceding case, the optimal capital and insurance premium combinations will satisfy the constraint that each individual bank will not "asset-substitute" given its minimum capital requirement and insurance premium. In addition, the menu offered to banks must be such that each bank not prefer a capital requirement–insurance premium rate combination intended for another bank type.

In general, the capital requirement–premium rate combinations that satisfy these incentive-compatibility constraints will differ from those that solve the policy problem where there is imperfect monitoring but complete information. For example, if banks were offered a menu of contract terms taken from columns 1 and 2 of Table 3—the capital requirements and premium rate combinations that maximize firm values under the full information assumption—bank optimizing choices would not identify their types. Given such a menu, all banks would claim to have a type A investment opportunity set.

If bank A is excluded from the table, the fair-pricing contract terms for the remaining banks in Table 3 show a monotonic inverse relationship between the contract's capital requirement and its insurance premium. The inverse relationship is consistent with the ordering of terms proposed by Chan, Greenbaum, and Thakor (1992) as an incentive-compatible policy when the regulator is not completely informed of banks' specific investment opportunity sets. This inverse relationship will not, however, produce a correct sorting of banks in the table as type B and D banks would reveal themselves to be type C banks. They would choose higher risk investments and produce lower EVAs than the full information results presented in Table 3, and their insurance would be underpriced.

Table 4
OPTIMAL INCENTIVE-COMPATIBLE CAPITAL REQUIREMENTS AND FAIR INSURANCE RATES WITH INCOMPLETE INFORMATION

Bank	Required Bank-Capital Ratio[a]	Premium Rate	Economic Value-Added	First-Best Economic Value-Added[b]	Net Insurance Value
A	≥ .351	0	52.17	59.33	0.00
B	≥ .351	0	54.16	55.35	0.00
C	≥ .351	0	49.59	53.58	0.00
D	≥ .351	0	55.36	64.08	0.00
			211.28	232.34	

[a] Banks A, C, and D will optimally operate at the minimum required capital ratio. Bank B will optimally choose to operate at a capital ratio of .423.

[b] Figures taken from Table 2.

The optimal solution to the incentive-compatible contracting problem is given in Table 4. The optimal incentive-compatible contract imposes a uniform minimum risk-asset capital requirement and a uniform insurance premium on all banks. Bank EVAs also are mostly smaller than those presented in Table 3. This occurs because greater limits on regulators' information impose additional incentive-compatibility conditions on the regulator that constrain further the set of feasible policies from which to choose. Given the bank investment opportunities (and equity issuance costs) in this example, the incentive-compatible policy even fails to distinguish banks. However, because it allows for some deposit-financed lending, the optimal policy is still more efficient than the narrow banking solution.

Contracts like those in Chan, Greenbaum, and Thakor (1992) fail to generate a separating equilibrium in this example because our investment opportunity set and financing structures are more complex than those that underlie their model. By assumption, all bank loan investment opportunity sets in Chan, Greenbaum, and Thakor can be ranked according to first-order or second-order stochastic dominance.[13] In our model, the set of possible asset portfolios represents investment opportunities whose combinations of risk, NPV, and financing requirements do not fit any well-defined risk ordering. In particular, the opportunity sets cannot be uniquely ordered by a one-dimensional risk measure such as first- or second-order stochastic dominance.

This last example illustrates that, with less stylized investment opportunity sets, designing incentive-compatible policies that achieve a high degree of sorting among bank types can impose formidable information requirements on regulators. In some respects, the information assumptions made here are still very strong in that regulators are unlikely to have a clear idea of the constellation of investment opportunities available to banks. In the present model, if regulators had to consider a wider set of investment opportunities for each bank than the four assumed, an optimal policy would produce an economic value-added for each bank somewhere between that shown in Table 4 and the results under a narrow banking approach.

5. Conclusions

The preceding analysis has shown the difficulties inherent in designing an optimal bank regulatory policy where commonly used modeling stylizations on banks' investment and financing choices are relaxed. When banks can issue equity at the risk-adjusted risk-free rate, a common modeling stylization, collateralization of deposits with a risk-free asset costlessly resolves moral hazard inefficiencies and insurance pricing issues addressed in the literature. With costly equity issuance, this narrow banking approach can impose large dead-weight financing costs and reduce positive NPV investments funded by the banking system. When equity issuance is costly, the most effective and efficient capital requirements are bank-specific, as they depend on individual banks' investment opportunities and financing alternatives. Directly implementing optimal bank-specific capital requirements, however, requires detailed regulatory information on the investment opportunities and financing alternatives of individual banks.

Incentive-compatible designs have been proposed in the theoretical literature as a way of minimizing regulatory intrusiveness and information requirements in obtaining optimal bank-specific results. However, in relaxing previous modeling stylizations, we found that heavy information requirements also inhibited incentive-compatible designs in obtaining optimal bank-specific results. Despite the potential benefits of incentive approaches over rigid regulations, feasible approaches are still likely to be substantially constrained by limited regulatory information and by "level playing field" considerations and thus are likely to be decidedly suboptimal at the individual bank level.

ENDNOTES

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1. For example, see Gennotte and Pyle (1991); Chan, Greenbaum, and Thakor (1992); and Giammarino, Lewis, and Sappington (1993) for use of stochastic dominance assumptions.

2. For example, see Chan, Greenbaum, and Thakor (1992); Giammarino, Lewis, and Sappington (1993); Kim and Santomaro (1988); John, John, and Senbet (1991); Campbell, Chan, and Marino (1992); and John, Saunders, and Senbet (1995).

3. Franchise value may arise from continuing access to positive NPV loan opportunities, the ability to offer transaction accounts at a profit, and the net value of deposit insurance in future periods.

4. $\frac{d_1}{1-d_1}P_D$ is a hypothetical value of the distress costs the bank would face if it could not default on its deposit obligations. Because bank shareholders will not have to bear distress costs for portfolio value realizations less than j_d, the default threshold, the term $\frac{d_1}{1-d_1}P_I$, credits shareholders with the default portion of the distress costs.

5. See Kupiec and O'Brien (1998) for a more complete development of the option components of the bank's net shareholder value.

6. This assumption is consistent with the regulatory policies analyzed below.

7. See James (1991) for a description and estimates of bank closure costs.

8. The fairly priced premium will equal the insurer's liability value if the insurer's costs in liquidating the bank are the same as the distress costs to shareholders (see above).

9. Flannery (1991) emphasizes this point and considers the consequences for insurance pricing and bank capital policy, although his analysis does not incorporate moral hazard behavior.

10. In terms of earlier notation (see equation 1), the second period cash flow from loan i is $j_{i1} + I_{i0}e^{\mu_i + s_{0i}z_0 + s_{1i}z_{1i}}$, where I_{i0} is the bank's initial required outlay for loan i, μ_i the expected return, $s_{0i}z_0$ the systematic risk component, $s_{1i}z_{1i}$ the idiosyncratic component, and the z terms are independent standard normal variates. The initial value of loan i is $j_{i0} = I_{i0}e^{\mu_i + \frac{1}{2}(s_{0i}^2 + s_{1i}^2) + \lambda s_{0i} - r}$, where λ is the market price of risk and r the one-period risk-free rate. For positive NPV loans, $j_{i0} > I_{i0}$.

11. The shareholder equity maximization problem is solved numerically using integer programming as described in equation 2 above. As the sum of lognormal variables is not lognormal and does not have a closed form density function, all option values are calculated using numerical techniques. A lognormal distribution approximation to the sum of lognormal variables is used (see Levy [1992] for details). Option values from the use of the lognormal approximating distribution were similar to values calculated using Duan and Simonato's (1995) empirical martingale simulation technique.

12. See Kupiec and O'Brien (1998) for the formal incentive-compatibility conditions.

13. This ordering is also assumed in Giammarino, Lewis, and Sappington (1992); John, John, and Senbet (1991); and John, Saunders, and Senbet (1995).

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Issues in Financial Institution Capital in Emerging Market Economies

Allen B. Frankel

I. Introductory Remarks

For the past twenty years, Asia has been regarded as an economic success story. The recent economic turmoil in the region, however, has prompted a reevaluation of the long-term sustainability of the dynamic economic performance. Undoubtedly, lessons will be drawn from the Asian experience—lessons that will inform future decisions at various levels to move financial liberalization forward while providing for prudential concerns.

Many thoughtful analysts surveying the Asian experience have focused on the inadequacies and inefficiencies in the banking systems of Asian nations as particularly significant elements in precipitating the current crisis. The banking problems of these nations, however, only bring into specific relief deep, complex, and more pervasive problems in the institutional arrangements of the affected nations—problems that are, in fact, common to many emerging market countries throughout the world. These issues have particular relevance to the consideration of future financial liberalization and the broadening of the international financial community via multilateral trade negotiations and international understandings among national financial supervisors.

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II. An Outline of the Policy Problem

This paper sets out to discuss a policy problem involving the integration of emerging market banking systems into international financial markets. Below is an outline of the policy problem:

Policy problem. Promote financial market liberalization in emerging economies through the exploitation of international financial linkages, including interbank transactions.

Constraint. Satisfy system-wide prudential policy needs.

Premise. As long as entry of foreign banks is restricted, domestic banks have superior capacity to gather information on domestic economic actors and discriminate among those actors.

Instruments that can be applied to the solution of the policy problem:

- robust institutional arrangements;[1]
- design of macroeconomic policy instruments;
- binding international agreements such as the Financial Services Agreement of the General Agreement on Trade and Services; and
- multilateral understandings such as the Basle Core Principles.

This paper is organized as follows. In Section III, we explicate the policy problem through an overview discussion of the Asian experience. In Section IV, we consider institutional deficiencies in emerging market countries and their negative implications for prudent banking. We also extend the discussion to include the impact of institutional issues on the credit relationships between domestic and foreign banks. In Section V, we discuss the relevance of trade agreements in financial services and agreements among supervisors to the process of integrating emerging markets into international banking markets. Drawing on the insights of incomplete contracting theory, we consider how the involvement of emerging market countries might influence both the form and the coverage of multilateral agreements covering prudential standards.

III. Putting the Policy Problem in Context

Our statement of the general policy problem has been informed by the Asian experience. Many observers link the poor macroeconomic performance of Asian emerging market countries in the recent past to an inconsistency in economic policy: although these countries encouraged domestic institutions to be actively involved in international financial markets, they did not at the same time aggressively pursue domestic institutional reform. The Asian economies made efforts to implement financial market liberalization by removing restrictions, for example, on the character and magnitude of funding activities that Asian banks could conduct in international interbank markets.

Over the last decade, Asian governments sought to support the preeminent role of their banking systems as sources of finance for investment projects by removing interest rate controls and by initiating other liberalizing measures designed to avoid disintermediation. The policies were successful in that they permitted seemingly well-capitalized banks to assume investment responsibility for large amounts of domestic and foreign savings. They were unsuccessful, ex post, in that many of the projects financed did not generate sufficient revenues to meet contractual loan payments. The eventual result has been the current crisis in Asia, which has generated both domestic economic problems in affected Asian countries and concern about the impact on banks in other countries. This outcome can be associated with the deficient state of institutional arrangements in emerging Asian economies. In particular, these economies commonly lack complete legal arrangements as well as well-developed mechanisms to produce good accounting information. In turn, this produces a lack of transparency in corporate financial affairs, distorted incentive structures for economic agents, and a lack of certainty as to the locus of corporate control. In the next section, we will look more closely at how the deficient institutional arrangements create difficulties for the making of prudent credit decisions and can in fact generate prudential concerns.

IV. Institutional Failings: Asian Examples

A. Accounting, Monitoring, and Macroeconomic Policy

As noted above, many emerging market countries lack strong accounting mechanisms and traditions. Numerous factors may contribute to these weaknesses. First, many countries lack legal requirements for the independent auditing of financial statements. Second, the limited penetration of sophisticated accounting systems in many emerging market countries reduces the quality and timeliness of financial data. In addition, the lack of liquid, well-developed asset markets in these nations often limits the validity of financial information; companies must use internal estimates of values rather than objective, transparent, market-based observations. Finally, the values of corporate transparency, avoidance of conflicts of interest, and safeguarding of corporate assets are not fully ingrained in some of the emerging markets.

Furthermore, macroeconomic policies in emerging markets often make prudent banking more difficult, as foreseeable consequences of those policies cannot be managed readily by emerging market banks with underdeveloped risk management systems. As the Asian experience demonstrates, the choice of exchange rate regime can introduce instability into the domestic banking markets. To some extent, this occurred in Mexico in 1994 and 1995. The most striking example of this phenomenon, however, took place in Chile in the late 1970s. Diaz-Alejandro

(1983) reported that real lending rates in Chile averaged more than 75 percent per annum over the period 1975-82. It was not surprising to him that, in these circumstances, Chilean banks borrowed heavily in foreign currency and lent the proceeds to domestic customers. Finally, he noted that Chilean banks had not taken into account the substitution of exchange rate risk exposure for credit risk. This failure, in turn, contributed to Chilean bank failures.

Stylized Example

To provide additional insight into the impact of these institutional issues on banking markets, we will present a stylized example based on the Asian experience. To begin with, let us consider the economic and financial circumstances present in Asia.

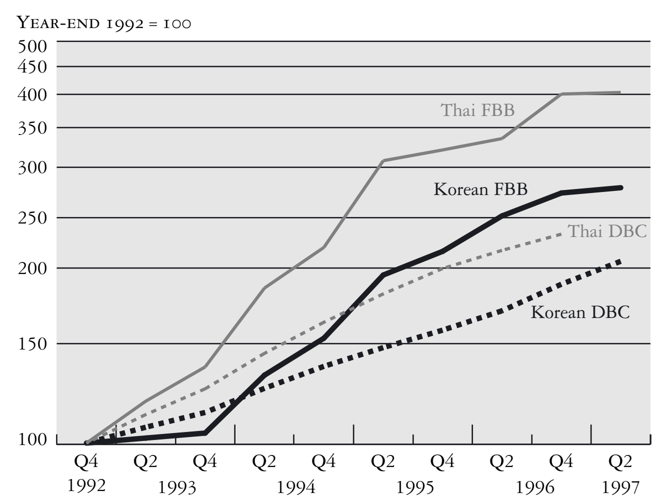
The slowdown in economic growth in Asia has been reflected in sharp deteriorations in the cash holdings (liquidity) of Asian companies.[2] It seems apparent, based on available data, that in some cases companies chose to respond to these cash squeezes by taking on currency risk through arrangement and drawdowns of hard currency credit facilities from domestic and foreign banks. Companies found these hard currency credit facilities attractive because they permitted the companies to reduce the rate of drawdown of their cash reserves by lowering interest payments. The reduced cash flow came at the cost of the assumption of financial risk of a depreciation of the domestic currency.

The chart shows data for two countries: Korea and Thailand. For both of these countries, there was a strong association of the buildup of the foreign borrowing of domestic banks with the increase in domestic credit extensions to the domestic private sector. The greater steepness of the foreign bank borrowing line in both cases is consistent with a story that external bank borrowing was undertaken to accommodate the corporate sector's heightened interest in conserving scarce cash liquidity. We would caution, however, that available data do not permit us to verify the presumed behavior that banks passed on the currency risk to liquidity-constrained corporate borrowers.

Now let us develop our stylized example. Consider the following circumstances regarding the exchange rate environment. The monetary authorities are seeking to avoid currency depreciation through open-market purchases. To hold a position in the domestic currency, market participants require compensation in the form of higher domestic interest rates for the anticipated future depreciation.[3]

Let us assume that the borrowing behavior described above is sufficiently prevalent among the borrowers of a particular bank that a depreciation of the exchange rate would significantly increase the credit exposures of that bank. Furthermore, assume that the bank's credit decisions are based on a single criterion, the borrower's credit history, reflecting the only information available to the bank.[4] This assumption is based on the notion that domestic corporates either do not prepare financial data or that the data they prepare are of highly uncertain value and therefore cannot be relied on as a basis for credit decisions. An important characteristic of the data on the borrowing history is that they have only been accumulated during an observation period in which the sensitivities of borrowers' financial situations to exchange rate movements could not be observed.

FUNDING OF DOMESTIC BANK CREDIT IN INTERNATIONAL INTERBANK MARKETS



Sources: Various editions of *The Maturity, Sectoral and Nationality Distribution of International Bank Lending*, Bank for International Settlements Monetary and Economic Department, and *International Financial Statistics*, International Monetary Fund, January 1998.

Notes: FBB = foreign currency borrowing by domestic banks. DBC = domestic bank credit to private sector Korean borrowers and to nonfinancial private Thai firms.

Now, let us consider the consequences to the bank of a depreciation of the currency. The immediate impact of the depreciation would be to increase exposures to all borrowers who have been loaned funds in the foreign currency. The bank, given the information available, would have no way to assess the consequences of the depreciation on the ability of any particular borrower to pay. The depreciation may have impaired the ability of some borrowers, who are unhedged, to honor their debt obligations. Other borrowers, however, who are effectively hedged (for example, those who have receivables denominated in the foreign currency) would not be adversely affected by the depreciation. Let us assume that a borrower of each type approaches the bank to restructure its loan. Each borrower requests that its loan payment, expressed in domestic currency, be no more than required before depreciation. Given the absence of firm financial information, the bank has no objective basis to differentiate among the two applicants for debt relief. Thus, the bank faces the possible result that if it gives concessional terms to both applicants, it has advantaged one unnecessarily. If it does not permit the concessional terms, it forces one borrower into bankruptcy unnecessarily. And if it takes the final choice and offers one concession and denies the other, it faces the possibility of ending up in the worst of possible worlds in which one borrower defaults and the other is unnecessarily provided with reduced payments.

Now let us bring the domestic bank/foreign bank relationship into our analysis. Assume that the only information disclosed to a foreign bank is data on the level of nonperforming loans of the domestic bank. In the period before depreciation, differences in the levels of nonperforming loans among banks would not have systematically revealed the hedging or nonhedging of these banks' borrowers. The analysis above suggests that if the concentration of a bank's loans is to unhedged borrowers, then depreciation might result in a large increase in nonperforming loans. But this characteristic of the bank's loan portfolio would be revealed only ex post. This demonstrates how the foreign bank, in the absence of effective monitoring mechanisms, would not have the wherewithal to alter the way it processes information and makes credit decisions. Such mechanisms could inform decision making at foreign banks, and could therefore lead to avoidance of exposures to those domestic banks likely to be affected by a currency depreciation.

This example suggests the potential value of forward-looking information. Such information can be produced by stress tests.[5] The tests are particularly useful when historical experience has been limited by successful government efforts to fix asset prices (most prominently, fixed exchange or interest rates). The information drawn from these tests can support alternate projections of cash flows, so bank managements can take various contingencies into account for purposes of capital planning.[6]

B. The Bankruptcy Regime

Let us now turn to the relevance of a country's bankruptcy regime on the relationship between the domestic bank and the domestic borrower as well as between the foreign bank and the domestic bank. We will consider how deficient rules for corporate debt workouts, and in particular violation of the absolute priority rule (APR), undermine the ability of both domestic banks to make credit decisions on the corporate level and foreign banks to make discriminations among domestic banks in the interbank market. Again, the experience of Asia is both especially instructive and particularly relevant.

Economic analysis of bankruptcy arrangements has focused on the impact of the bankruptcy regime, and in particular the absolute priority rule, on the efficiency of financial contracting (see Longhofer [1997]). The absolute priority rule provides for the retention in bankruptcy of the priority of claims established outside of bankruptcy. In other words, the most senior creditors should be paid off before anything is given to the next senior creditors, and so on down to the shareholders.

Asian countries appear to have a high tolerance for violations of APR. This has been traced by legal scholars to Asian cultural traditions as well as to the influence of European civil law heritages in a number of countries, including Indonesia.[7] The character of significant violations of APR, which we think are prevalent, is suggested by the following examples. In a recent restructuring of a major Thai company with $330 million in debt, creditors will forgive 95 percent of their debt and shareholders will retain an interest in the company. The terms reflect the power of the dominant shareholder to veto proposed restructuring arrangements, a widely recognized shortcoming of Thailand's bankruptcy arrangements.[8]

In the case of Korea, violations of APR have been associated with the behavior of entrenched managements. The managements of bankrupt chaebols and other large Korean companies have been able to apply for court mediation which, when granted, has permitted them to stay in place. This process violates the absolute priority rule because control of corporate assets has not been transferred to the new owners. The Korean government has now proposed legislation that restricts the opportunities of managements at troubled companies to entrench themselves.[9]

Now let us evaluate the impact of violation of APR on the creditor relationship between the domestic bank and borrower. The higher the probability of APR violations in a given legal structure, the less incentive owners/managers have to avoid bankruptcy. The lessened incentive reflects the diminished discrepancy in outcomes between the bankruptcy and nonbankruptcy states. In these circumstances, the domestic creditor bank would be less favorably treated than in the absence of APR violations.

Consider the case where the domestic bank does have special ability vis-à-vis foreign banks to discriminate between domestic companies as to the likelihood of default. The presence of such a superior capacity helps explain why foreign banks would choose to fund domestic banks' extensions of credit to domestic borrowers. That is, the presence of APR violations enhances the domestic banks' advantage.

To summarize, badly structured bankruptcy regimes can result in the increased likelihood of bankruptcy (because of the reduction in incentives) and reduced recoveries in states of bankruptcy, and thus will tend to reduce the attractiveness for creditors of debt positions in those economies. As well, poor bankruptcy arrangements increase the likelihood that foreign banks will use domestic banks as intermediaries in lending relationships with domestic corporate borrowers.

Our analysis above provides a basis for the presumption that the interests of emerging market countries would be served by addressing institutional failings. Additionally, instability in domestic financial markets associated with such institutional arrangements could be transmitted to international markets. Therefore, international supervisors also have incentives for evaluating the state of institutional arrangements in emerging market countries when considering whether and how to negotiate on international prudential and financial liberalization issues.

V. Multilateral Agreements

This section reviews the consequences of the size and composition of the group participating in international prudential and liberalization agreements on the contractual character of those agreements. In particular, we focus on the significance for international liberalization and supervisory arrangements on the inclusion of emerging market countries. In connection with this discussion, we review three agreements: the Basle Capital Accord, the Financial Services Agreement of the General Agreement on Trade and Services, and the Basle Committee's Core Principles for Effective Banking Supervision.

A. Basle Capital Accord

The Basle Capital Accord is an understanding among the bank supervisory agencies of the G-10 member countries. The agreement, signed in 1988, was undertaken during a period when these authorities expressed interest in a shared-rule framework for judging the financial strength of applicant banks, which were, at that time, primarily from each other's countries. The thrust of the revised Basle Accord (updated to include the coverage by capital regulation of market risks) can be summarized as follows:

1. A bank must hold equity capital equal to at least a fixed percent of its risk-weighted credit exposures as well as capital to cover market risks in the bank's trading account.

2. When performance causes capital to fall below this minimum requirement, shareholders can retain control provided that they recapitalize the bank to meet the minimum capital ratio.

3. If the shareholders fail to do so, the bank's regulatory agency is required to sell or liquidate the bank.

The Basle Accord provides de facto liberalization by establishing a transparent standard for the crucial variable, capital, that is used in making judgments on various applications, including those for entry, of foreign banks. Due to its transparent framework and simplicity, the agreement operates to limit discretion for supervisors in signatory countries and other countries that voluntarily chose to adhere to it.

It is instructive to consider what lessons the Accord provides regarding the factors that influence the outcome of contracting among groups of national supervisory authorities. Economic analysis of contracting would suggest that the small size and homogenous character of the group of signatories explain the simplicity of the Basle Capital Accord. These characteristics allowed the negotiations to be effectively limited to questions involving capital issues.[10] Additionally, the cost and complexity of negotiations were reduced as the agreement does not involve formal treaty obligations and accords flexibility in national implementation.

Let us consider the case that can be made to use the Basle Accord as a complete and controlling international prudential agreement covering all banking systems, including those of the emerging markets. Four characteristics of the Basle Accord are inconsistent with this case.

First, the framers of the Accord implicitly presumed that the signatory countries had compatible institutional arrangements. As discussed above, in many cases the institutional failings of emerging market countries make them incompatible with those of established financial centers.

Second, the Accord is an incomplete agreement that affords considerable discretion to national supervisory authorities. For example, it provides no guidance as to how signatory supervisors should address failures of bank shareholders to meet agreed minimum requirements. The disparate implementation of prompt corrective action initiatives in the United States and Japan affirms this observation.[11] Additionally, the Accord offers no specific guidance as to the circumstances in which a host country supervisor may close a branch office of a foreign bank.[12] Because of the incomplete nature of the contract, national supervisors in G-10 countries have had to expend considerable effort to make adaptations and to develop informal understandings in order to keep the Basle Accord relevant and useful. Enlargement of the group of nations consulted in this process would considerably increase the costs of reaching consensus on modifications of the Accord and could possibly discourage needed adaptations.

Third, the Basle Accord is tightly focused on issues related to capital measurement and the setting of minimum capital adequacy standards. For example, it does not offer standards for banks' efforts to identify, measure, monitor, and control material risks. It would be important to reach agreement on standards such as these if the group of countries negotiating standards became more diverse.

Fourth, there is no formal enforcement mechanism in the Accord. In the signatory countries, there has been an increased understanding that formal enforcement mechanisms such as prompt corrective action are required at the national level. The same view, however, has not become as widely accepted in emerging market countries. In the absence of an enforcement mechanism, enlargement of the signatory group risks the introduction of a rogue national banking system into international markets. The presence of such a rogue signatory could undercut the understandings on which the normal functioning of the international interbank markets are based.

B. The General Agreement on Trade and Services and the Basle Core Principles

In this section, we will consider how emerging markets might be brought into the Basle-based discussions. To begin, however, it is important to appreciate the importance of the separate process of negotiating international liberalization organized under the aegis of the World Trade Organization.

The General Agreement on Trade and Services (GATS) promotes competitive and efficient markets worldwide. In particular, the Financial Services Agreement of GATS brought trade in financial services into a global multilateral framework comparable to that provided for trade in goods (see Key [1997]). The agreement calls for a process of liberalization involving the reduction or removal of barriers to foreign financial services and foreign financial services providers from national markets.

The coverage of financial services by GATS is modified by the so-called prudential carve-out. The carve-out permits signatory countries to take measures for prudential purposes notwithstanding other GATS provisions. However, limited guidance has been provided as to what constitutes prudential measures. It is clear only that the carve-out permits measures for the protection of various classes of stakeholders such as policyholders and depositors or "to ensure the integrity and stability of the financial system." Therefore, fleshing out the meaning of the prudential carve-out requires reference to alternative sources.

Consider the character of guidance that would be provided for this concept by the recently drafted Basle Core Principles for Effective Banking Supervision. The Core Principles are intended to serve as a basic reference for supervisory and other public authorities. That is, they provide general, not detailed, guidance on an extensive listing of topics (see Basle Committee on Banking Supervision [1997]). The Core Principles were drafted by representatives from the Basle Committee's G-10 member countries and nine emerging market countries. Supervisors from all countries, however, are being encouraged to endorse the Core Principles. The Basle Core Principles comprise twenty-five basic standards that relate to: preconditions for effective banking supervision (Principle 1), licensing and structure (Principles 2 to 5), prudential regulation and requirements (Principles 6 to 15), methods of ongoing banking supervision (Principles 16 to 20), information requirements (Principle 21), formal powers of supervisors (Principle 22), and cross-border banking (Principles 23 to 25).

The Core Principles employ the concept of capital regulation established in the Basle Accord. To this they add an extensive set of supervision issues. One might interpret the greater breadth of the Principles as reflecting the now-established international sentiment that improvements need to be made in the supervisory systems of many countries.

VI. Alternatives to the Basle Accord Methodology

The breadth of the Core Principles may make them more useful than the Basle Accord for extended application to the emerging market countries. As noted, however, the Core Principles still make use of the Basle Capital Accord. Therefore, some of the same arguments against the further expansion of Basle Accord signatory countries apply to the Core Principles as well. There is rather broad agreement that the Accord's methodology has flaws, but certainly no consensus on what, if any, alternative could or should replace it. In this section, we will make some observations regarding two of these alternative prudential methodologies. We will first consider fair pricing of deposit insurance and then the so-called precommitment approach.

A. Fair Pricing of Deposit Insurance

John, Saunders, and Senbet (1995) have argued that countries should adopt fairly priced deposit insurance to avoid the distorting consequences for resource allocation associated with capital regulation. They argue that appropriate risk-adjusted deposit insurance premiums would provide bank owners with incentives to put in place optimal management compensation structures. The motivation for such a scheme would be to induce managers to avoid taking risks beyond those that are optimal for an "all-equity-financed bank."

The experience in the United States indicates that implementation of risk-adjusted premiums is a politically difficult task. The range of risk-adjusted premiums now charged by the Federal Deposit Insurance Corporation is about 30 basis points, well below the approximately 100-basis-point range routinely estimated by researchers in the early 1990s as required to adequately account for risk differences among banks. The European experience also suggests that gaining agreement among countries on adopting risk-adjusted premiums would not be an easy task. In 1993, the European Commission issued the Directive on Deposit Guarantees requiring EU member nations to adopt a national system of deposit insurance that met broadly agreed-upon standards.[13] National authorities were given wide latitude, however, in implementing the

Directive in their home countries. Countries chose a wide variety of implementation mechanisms; only two, however, chose risk-adjusted premiums.[14]

B. The Precommitment Approach

Now let us consider the possibility of substituting a precommitment-type approach for the current Basle Accord methodology. Under the precommitment approach, a bank commits to its regulator that it will not exceed a certain magnitude of loss for a period to come. Each bank determines this amount on its own. If the bank violates this commitment, then it faces a penalty, which must be viewed as credible in order for the approach to be effective.

To date, there has been little, if any, discussion regarding the challenges involved in ex post verification of periodic profit-loss outcomes. The reason for this dearth of deliberation seems clear—the precommitment approach raises no new issues in economies with strong accounting traditions and systems. However, if consideration were to be given to emerging market banks employing such an approach, verification would become an issue due to institutional shortcomings in these countries. In particular, recent discussions on the current operation of emerging market banking systems suggest that these systems are often characterized by a lack of transparency, a scarcity of supervisory personnel with requisite technical training, incomplete avoidance of conflicts of interest, and lax safeguarding of corporate assets by system participants. These deficiencies could undermine the verification procedure, which is a key aspect of a self-assessed regulatory approach. This discussion suggests that, at present, there are significant barriers to the use of incentive-compatible regulatory schemes in emerging market economies.

VII. Enforcement Mechanisms

So far, we have considered various international agreements and frameworks for dealing with prudential concerns and their relevance to a world in which a growing and increasingly diverse group of countries participate in international markets. As our final topic, we will discuss the arguments related to the choice of whether to include enforcement mechanisms in multilateral agreements on capital adequacy and associated prudential issues.

The argument for rewards and penalties is to provide incentives to participant countries to take actions that would tend to improve prospects for stability of the international financial system. Two obstacles, however, must be overcome. First, it would be difficult to ensure that enforcement actions are applied fairly and to insulate them from forces other than those related to prudential concerns. Second, supervisors would more closely scrutinize any proposals if the proposals were connected to a binding agreement. This would increase the difficulty of negotiating an agreement.

VIII. Concluding Remarks

A lesson of the Asian financial crisis concerns the macroeconomic costs of poorly designed institutional structures. One of the possible explanations for the persistence of the tolerance of these structures may be that they afford a competitive advantage to domestic financial institutions of emerging market countries. The competitive advantage of these banks is based on their value as intermediaries between international markets and domestic agents. This value arises from their knowledge of the intricacies of the institutional structures in their home countries.

Much of our discussion of the policy problem assumes that, going forward, emerging market supervisors will be included in the negotiation of multilateral supervisory understandings. The analysis of the paper suggests that their participation will influence the outcome of the nature of understandings among regulators. In particular, the outcome would likely result in an attainable standard that is consistent with a process of institutional reform over time. During this period of reform, emerging market banks would be insulated from the full consequences of market discipline and thus would retain some protection of their competitive status. This would result in an agreed-upon strategy for integrating emerging market banking systems into international markets.

When relaxing the assumption that emerging market supervisors must agree to an international supervisory standard, the standard would move toward one that permits the most efficient employers of bank capital to fully exploit their competitive advantages. In the absence of protected franchises, few emerging market banks would be able to compete in the market for equity capital at this time. Under these conditions, one possible response of emerging market authorities could be to close off their markets to avoid direct competition between more efficient foreign banks and their less efficient domestic institutions. This could well be accompanied by lessened emphasis on institutional reform efforts. The costs of these policy measures would presumably be less real economic integration of emerging market economies with the international economy. We also cannot discount the possibility that the less complete and more slowly implemented institutional reforms will have a negative impact on systemic risk. This might occur if market participants failed to take into account in their own risk management actions a scaling back of the market-oriented oversight of banking and other financial supervisors in emerging market economies.

ENDNOTES

The author wishes to acknowledge the extraordinary assistance provided by Garrett Ulosevich in the preparation of this paper. This paper presents the views of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff.

1. See Annex of *Financial Stability in Emerging Market Economies*, Report of the Working Party on Financial Stability in Emerging Market Economies. This report is available on the World Wide Web at the Bank for International Settlements' site (http://www.bis.org). It provides an illustrative List of Indicators of Robust Financial Systems. The six main headings of the listing are: 1) legal and juridical framework; 2) accounting, disclosure, and transparency; 3) stakeholder oversight and institutional governance; 4) market structure; 5) supervisory/regulatory authority; and 6) design of the safety net.

2. Korean data for deposits at banks by individuals and corporations show much stronger increases in growth of deposits of individuals in 1996 and 1997. In addition, Korean data show sizeable increases in foreign-currency-denominated bank loans equal to 47 percent between the end of 1995 and the end of the third quarter of 1997. That is, the Korean data appear to be broadly consistent with the circumstances described in the stylized example (Bank of Korea 1997).

3. See Krugman (1996) for a discussion of conventional currency crisis theory. See Krugman (1998) for an exposition of a model that concentrated on the problem of moral hazard in the financial sector and its macroeconomic consequences.

4. In the discussion of the stylized example, we abstract from the possible use of collateral. The credit policies in many emerging market economies are asset based rather than cash-flow based. Because banks do not require information on cash flows of the underlying asset, they are unable to evaluate independently the asset's value through discounted cash flow or similar methodologies. In such circumstances, collateral should provide the lender less comfort than when the collateral-assumed values are consistent with estimates derived from a discounted cash-flow analysis.

5. See Gibson (1997) for a discussion of how the design of an information system depends on the risk measurement methodology that a bank chooses.

6. For a discussion of the usefulness of cash-flow analysis in emerging market countries, see Kane (1995).

7. For overview discussions of the administration of insolvency laws across Asia, see Tomasie and Little (1997). Tomasie and Little have commented on the impact of Confucian philosophy on the resolution of financially troubled companies in Asia. They suggest that the cultural ideal of communal risk bearing results in an unwillingness to visit total loss on any class of stakeholders. Tomasie and Little have also commented on the separate influence of the European civil law tradition. They have observed that under this tradition, judges look first to the satisfaction of public policy objectives and only then consider the proposed resolution's consistency with the structure of creditor preference outside of bankruptcy. For a more general discussion of how the character of legal rules and the quality of law enforcement affect financial activity, see La Porta et al. (1996, 1997).

8. See Sherer (1998) for an article on the restructuring plan proposed for Alphatec Electronics PLC.

9. To address this situation, the Korean government proposed legislation, in early 1998, that would restrict the circumstances in which management could apply to the courts for protection. Under current Korean law, a company can file for liquidation, reorganization, or court mediation. It is estimated that almost all large company filings have been for court mediation. Korean commentators have asserted that filings for the court mediation option are often undertaken by managements seeking to retain authority rather than for the purpose of present liquidation. Under the proposed legislation, debtor companies would not be permitted to withdraw from a proceeding once an order has been issued. It is anticipated that this change would address the problem of management abuse of the process.

10. However, the agreement did not call for limiting the benefits to signatories. For example, applications to the Federal Reserve from banks from countries that adhere to the Accord are required to meet the Basle guidelines as administered by their home country supervisors. An applicant from a country not subscribing to the Basle Accord is required to provide information regarding the capital standard applied by the home country regulator, as well as information required to make data submitted comparable to the Basle framework. See Misback (1993).

11. The gist of the U.S. implementation of prompt corrective action is to limit the discretion available to regulators with respect to the actions they require bank owners to take in response to lowered capital ratios. In contrast, the Japanese implementation can be interpreted as providing a menu of options for supervisors.

12. In its use here, the term Accord should be broadly construed to refer to the public documents that have been issued by the Basle Committee.

13. For details on the EU Directive on Deposit Guarantees, see McKenzie and Khalidi (1994).

14. Portugal and Sweden employ risk-adjusted deposit insurance premiums. The only other foreign countries with risk-adjusted deposit insurance premiums are Argentina and Bulgaria. See Garcia (1997).

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Commentary

Christine M. Cumming

In commenting on the three thought-provoking papers in this session, I would like to consider the first two papers together and then turn to the third.

From the standpoint of methodology, the first two papers could not be more different. The Estrella paper blends analytical and historical methodologies, with attention to supervisors' own understanding of their policies and practices, to consider the appropriate role of formulas and judgment in the supervisory assessment of capital adequacy. The Kupiec and O'Brien paper considers a series of results in the literature in the context of a more general model. Paul Kupiec and Jim O'Brien have done a great service in their paper by bringing these strands of the academic literature into a common framework. They help us to understand better the role of capital requirements and the interaction of capital requirements with risk management, the public safety net, and the short- and long-run optimization problems of firms, where franchise value is interpreted as capturing the long-run value of the firm as an ongoing concern.

The themes in the two papers, however, are very similar. Estrella emphasizes the dynamism and complexity of the financial system and, more particularly, of the rules and conventions that guide financial institution and supervisory behavior. In doing so, he draws on literature beyond economics that discusses the phenomenon of reliance on judgment and interpretation in the crafting and execution of rules and conventions. Reliance on simple quantitative rules applicable to all institutions—in Estrella's language, formulas—cannot work as supervisors would like them to.

In their paper, Kupiec and O'Brien make much the same point by generalizing the models used in the literature on capital requirements and deposit insurance pricing. Well-known policy prescriptions developed in models with certain assumptions change markedly with the relaxation of even one or two assumptions. In particular, for banks with different strategies or different investment opportunities, the "optimal" capital requirement—the requirement that shareholder value is maximized but moral hazard is minimized—is bank-specific. No two capital requirements are likely to be the same.

In both the Estrella and the Kupiec and O'Brien papers, the development of bank-specific requirements entails large amounts of information and a degree of precision that is not reasonable to expect of anyone, except the owners of the firm. As the world becomes more analytical, precise, and complex, it becomes all the more difficult to specify simple and hard-and-fast regulatory rules.

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Yet both papers see a role for capital requirements—to limit moral hazard, to benchmark information, and to provide a cushion to limit the social costs of a bank liquidation. If we look beyond these papers to actual practice, formulas such as minimum capital requirements appear to have additional purposes. Such requirements shorten the negotiation time to agreement between firm and supervisor on appropriate capital levels by providing a lower bound to the possible outcomes. A related consideration is transparency. Since the regulator has statutory powers to enforce capital adequacy, the considerations influencing its evaluation should be known to the financial firm, and the government should be able to demonstrate capital inadequacy in setting out any remedial action.

What, then, do the conclusions in these papers mean for supervisors?

First, capital requirements will necessarily be imperfect and have only temporary effectiveness. Second, the increasing sophistication and complexity of risk management in financial institutions call for more judgment in assessing capital adequacy. Third, capital cannot be considered in isolation, but has to be understood in the context of strategy, investment opportunities, risk management, and the cost of equity issuance. Capital requirements need to be seen in the broad context of supervisory activity, and capital adequacy supervision must necessarily involve some elements of supervisory judgment. Fourth, the conclusions in these papers help explain why we increasingly see a link between the quality of risk management and various supervisory rules and permissions. For example, the internal models approach includes both qualitative and quantitative criteria. With prompt corrective action and under the recently revised Regulation Y in the United States, limitations on activities and requirements to seek regulatory permission to conduct activities can be triggered by supervisory judgments, as reflected in the CAMEL or Management ratings given by U.S. supervisors during a bank examination. Finally, the results also help to explain the appeal of "hybrid" approaches described by Daripa and Varotto and by Parkinson; the supervisory approach described in Estrella's 1995 paper, "A Prolegomenon to Future Capital Requirements"; and the approach described in the Shepheard-Walwyn and Litterman paper.

In reading the Frankel paper, I found myself surprised. After the breadth of perspective in the previous two papers, Frankel moves the point of perspective higher and further back to survey the broad global scene, and generates the shock of the unexpected—the problems we just considered in Estrella and in Kupiec and O'Brien are yet more complex. The shock is reinforced by the contrast between the elegance of the two earlier papers and Frankel's candid observations.

Frankel's paper considers two sets of issues. First, he points out that certain preconditions have to be met for financial supervision to have any meaningful role. These preconditions include meaningful financial statements, publicly available on a timely basis, and a clear set of rules determining what happens when debtors cannot pay. In other words, we need to have adequate accounting, disclosure and bankruptcy principles established and applied in every country active in the international financial markets.

No one in this room is likely to disagree openly with his point. Frankel argues that the absence of these preconditions in some countries contributed to and exacerbated the recent crisis in Asia. Moreover, that crisis does seem to have created a defining moment for G-10 supervisors and central banks. The G-10 official community shows every sign that it agrees on the need to strengthen global accounting, disclosure, and bankruptcy rules and practices. What makes the moment defining is that these issues are not new—efforts have already been made to address them within the G-10 countries with mixed success, and the need for genuine success is all the greater.

That brings me to Frankel's second set of issues. I did not fully understand his arguments, but the issue of the respective roles of authorities in the G-10 and the emerging market countries in creating these preconditions is important. In my view, there is no question where leadership should come from. In the context of capital regulation, leadership from the G-10 countries—rooted in a perspective that encompasses the emerging market countries—suggests some considerations in evaluating possible approaches to twenty-first-century capital requirements. In particular, we might look for approaches that provide evolutionary paths for capital requirements, with financial institutions proceeding along the path at their own pace and consistent with the nature of their business strategy and risk management and internal control processes. The 1996 Market Risk Amendment to the Basle Accord, with its standardized and internal models approaches, represented one example of the creation of an evolutionary path.

One caution, however. The path concept cannot be seen as a reason to avoid moving expeditiously down the path or failing to put the preconditions described by Frankel in place. When you drive on the Autobahn, you cannot drive at 25 kilometers per hour or operate a car in need of repair.

The substantive issues raised by Frankel's paper are, what changes to the national and the international financial systems do we want and how much do we want them? The other issues he raises—who is a signatory to international agreements and whether and how to have some international enforcement mechanism to ensure minimum standards among participants in the international financial markets—are issues of process. We first have to work on agreeing on the substantive issues. The very process of forging a consensus is by its nature inclusive, and that suggests some clear considerations for the process issues.

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SESSION 7

THE FUTURE OF CAPITAL REGULATION

Remarks by

Tom de Swaan

Thomas G. Labrecque

Capital Regulation: The Road Ahead

Tom de Swaan

Introduction

It is a great pleasure for me to be here and to participate in the discussion of the future of capital adequacy regulation. I would like to compliment the organizers of this conference on the programme they have set up, covering many relevant topics, and the range of experts they have been able to bring together.

In my address, as I am sure you would expect, I will approach the issues from a supervisory perspective and in my capacity as chairman of the Basle Committee. Most of the questions that have arisen and been discussed here in the last two days are complicated, and many issues will require careful review. So do not at this stage expect me to provide clear answers on specifics. I do hope to be fairly explicit, however, on some of the more general issues at stake, in particular on the level of capital adequacy required for prudential purposes. In other words, my address today should be seen as part of the exploratory process that should precede any potentially major undertaking.

Tom de Swaan recently joined ABN AMRO Bank; on January 1, 1999, he will become a member of the managing board of the institution. At the time of the conference, he was executive director of De Nederlandsche Bank and Chairman of the Basle Committee on Banking Supervision.

Starting Point: The Basle Accord

When assessing the setup of capital regulation, I take as my starting point the Basle Capital Accord of 1988. It is commonly acknowledged that the Accord has made a major contribution to international bank regulation and supervision. The Accord has helped to reverse a prolonged downward tendency in international banks' capital adequacy into an upward trend in this decade. This development has been supported by the increased attention paid by financial markets to banks' capital adequacy. Also, the Accord has effectively contributed to enhanced market transparency, to international harmonization of capital standards, and thus, importantly, to a level playing field within the Group of Ten (G-10) countries and elsewhere. Indeed, virtually all non-G-10 countries with international banks of significance have introduced, or are in the process of introducing, arrangements similar to those laid down in the Accord. These are achievements that need to be preserved.

It is often said that the Accord was designed for a stylized (or simplified) version of the banking industry at the end of the 1980s and that it tends to be somewhat rigid in nature—elements, by the way, that have enabled it to be widely applicable and that have contributed to greater harmonization. Since 1988, on the other hand, banking and financial markets have changed considerably. A fairly recent trend, but one that clearly stands out, is the rapid advances in credit risk measurement and credit risk management techniques, particularly in the United States and in some other industrialized countries. Credit scoring, for example, is becoming more common among banks. Some of the largest and most sophisticated banks have developed credit risk models for internal or customer use. Asset securitization, already widespread in U.S. capital markets, is growing markedly elsewhere, and the same is true for the credit derivative markets. Moreover, one of the advantages of the Capital Accord, its simplicity through a small number of risk buckets, is increasingly criticized.

Against this background, market participants claim that the Basle Accord is no longer up-to-date and needs to be modified. As a general response, let me point out that the Basle Accord is not a static framework but is being developed and improved continuously. The best example is, of course, the amendment of January 1996 to introduce capital charges for market risk, including the recognition of proprietary in-house models upon the industry's request. The Basle Committee neither ignores market participants' comments on the Accord nor denies that there may be potential for improvement. More specifically, the Committee is aware that the current treatment of credit risk needs to be revisited so as to modify and improve the Accord, where necessary, in order to maintain its effectiveness. The same may be true for other risks, but let me first go into credit risk.

Objectives

Before going on our way, we should have a clear idea of what our destination is. One of the objectives for this undertaking is, at least for supervisors, that the capital standards should preferably be resilient to changing needs over time. That is, ideally, they should require less frequent interpretation and adjustments than is the case with the present rules. Equally desirable is that capital standards should accurately reflect the credit risks they insure against, without incurring a regulatory burden that would ultimately be unproductive. Substantial differences between the risks underlying the regulatory capital requirements and the actual credit risks would entail the wrong incentives. These would stimulate banks to take on riskier loans within a certain risk category in pursuit of a higher return on regulatory capital. To obtain better insight into these issues, we should further investigate banks' methods of determining and measuring credit risk and their internal capital allocation techniques. In doing so, however, we should not lose sight of the functions of capital requirements as discussed in the preceding session of this conference.

Moreover, the Accord should maintain its transparency as much as possible: with the justified ever-greater reliance on disclosure, market participants should be able to assess relatively easily whether a bank complies with the capital standards and to what extent. Especially in this respect, the present Accord did an outstanding job. Every self-respecting bank extensively published its Bank for International Settlements ratios.

Capital requirements foster the safety and soundness of banks by limiting leverage and by providing a buffer against unexpected losses. Sufficient capital also decreases the likelihood of a bank becoming insolvent and limits—via loss absorption and greater public confidence—the adverse effects of bank failures. And by providing an incentive to exercise discipline in risk taking, capital can mitigate moral hazard and thus protect depositors and deposit insurance. Admittedly, high capital adequacy ratios do not guarantee a bank's soundness, particularly if the risks being taken are high or the bank is being mismanaged. Therefore, supervisors consider a bank's capital adequacy in the context of a host of factors. But the bottom line is that capital is an important indicator of a bank's condition—for financial markets as well as depositors and bank regulators—and that minimum capital requirements are one of the essential supervisory instruments.

Guiding Principles

Therefore, it should be absolutely clear that, when it assesses the treatment of credit risk, the Basle Committee will have no predetermined intention whatsoever of reducing overall capital adequacy requirements—maybe even the contrary. Higher capital requirements could prove necessary, for example, for bank loans to higher risk countries. In fact, this has been publicly recognized by bank representatives in view of the recent Asian crisis. More generally, we should be aware of the potential instability that can result from increased competition among banks in the United States and European countries in the longer run. And we should not be misled by the favourable financial results that banks are presently showing, but keep in mind that bad banking times can—and will—at some point return. In those circumstances, credit risk will still turn out to be inflexible, still difficult to manage, and still undoubtedly, as it has always been, the primary source of banks' losses. Absorption of such losses will require the availability of capital. A reduction of capital standards would definitely not be the right signal from supervisors to the industry, nor would it be expedient.

Of course, I am aware of the effects of capital standards on the competitiveness of banks as compared with largely unregulated nonbank financial institutions such as the mutual funds and finance companies in the United States. Admittedly, this is a difficult issue. On the one hand, too stringent capital requirements for banks that deviate too much from economic capital requirements would impair their ability to compete in specific lending activities. On the other hand, capital standards should not per se be at the level implicitly allowed for by market forces. Competition by its very nature brings prices down but, alas, not the risks. If competitive pressures were to erode the spread for specific instruments to the point where no creditor is being fully compensated for the risks involved, prudent banks should consider whether they want to be involved in that particular business in the first place. It is therefore up to supervisors to strike the optimal balance between the safety and soundness of the banking system and the need for a level playing field. In the longer run, efforts should be made to harmonize capital requirements among different institutions conducting the same activities, or at least to bring them into closer alignment. A first exchange of views on this takes place in the joint forum on the supervision of financial conglomerates.

Another principle that the Basle Committee wants to uphold is that the basic framework of the Capital Accord—that is, minimum capital requirements based on risk-weighted exposures—has not outlived its usefulness. The rapid advances in credit risk measurement and credit risk management techniques are only applicable to sophisticated, large financial institutions. When discussing changes in the present Capital Accord, one should remember that it is not only being applied by those sophisticated institutions but by tens of thousands of banks all over the world. The Asian crisis has underlined once again that weak supervision, including overly lax capital standards, can have severe repercussions on financial stability. In the core principles for effective banking supervision published by the Basle Committee last year, it is clearly indicated that application of the Basle Capital Accord for banks is an important prerequisite for a sound banking system. Changes in the Capital Accord should take into account that the sophisticated techniques referred to above require among other things sophisticated risk management standards and a large investment in information technology—preconditions most banks in both industrialized and emerging countries cannot meet in the foreseeable future. Consequently, for these banks, the basic assumptions of the present Accord should be maintained as much as possible. Precisely because the Capital Accord is relatively simple, the framework is useful for banks and their supervisors in emerging market countries and contributes to market transparency.

Keeping that in mind, one should, however, acknowledge that the current standards are not based on precise measures of credit risk, but on proxies for it in the form of broad categories of banking assets. Indeed, banks regularly call for other (that is, lower) risk weightings of specific instruments. In order to obtain more precise weightings, the Basle Committee should be willing to consider less arbitrary ways to determine credit risks. But it is unrealistic to expect that internationally applicable risk weightings can be established that accurately reflect banks' risks at all times and under all conditions. Compromises in this respect are inevitable.

Credit Risk Models

A way out may be to refer to banks' own methods and models to measure credit risk, under strict conditions analogous to the treatment of market risks. At present, I would describe credit risk models as still being in a development stage, although the advances that some banks have made in this area are potentially significant. Ideally, as sound credit risk models bring forward more precise estimates of credit risk, these models will be beneficial for banks. Models can be and are used in banks' commercial operations—for example, in pricing, in portfolio management or performance measurement, and naturally in risk management. The quantification that a model entails implies a greater awareness and transparency of risks within a bank. More precise and concise risk information will enhance internal communication, decision making, and subsequent control of credit risk. Also, models enable banks to allow for the effects of portfolio diversification and of trading of credit risks or hedging by means of credit derivatives. So it can be assumed that a greater number of banks will introduce credit risk models and start to implement them in their day-to-day credit operations, once the technical challenges involved in modeling have been solved.

The more difficult question is whether credit risk models could be used for regulatory capital purposes, just as banks' internal models for market risk are now being used. As should be clear from what I have just said, credit risk models can have advantages from a prudential point of view. For this reason, the Committee is conscious of the need not to impede their development and introduction in the banking industry. However, there are still serious obstacles on this road. First, credit risk models come with substantial statistical and conceptual difficulties. To mention just a few: credit data are sparse, correlations cannot be easily observed, credit returns are skewed, and, because of the statistical problems, back testing in order to assess a model's output may not be feasible. Clearly, there are model risks here.

Second, if models were to be used for regulatory capital purposes, competitive equality within the banking industry could be compromised. Because the statistical assumptions and techniques used differ, it is very likely that credit risk models' results are not comparable across banks. The issue of competitive equality would be complicated even further by the potential differences in required capital between banks using models and banks using the current approach.

Third, and most important, a credit risk model cannot replace a banker's judgement. Models do not manage. A model can only contribute to sound risk management and should be embedded in it. This leads me to conclude that if credit risk models are to be used for regulatory capital purposes, they should not be judged in isolation. Supervisors should also carefully examine and supervise the qualitative factors in a bank's risk management and set standards for those factors. A possible stragegy would be to start applying models for a number of asset categories for which the technical difficulties mentioned before are more or less overcome, while at the same time maintaining the present—albeit reassessed—Accord for other categories. This clearly has the advantage of giving an incentive to the market to develop the models approach further so that the approach can be applied to all credits. On the other hand, it might jeopardize transparency.

Market Risk and the Precommitment Approach

Let me now make a short detour and discuss the supervisory treatment of risks other than credit risk. First, market risk. Although the internal models approach was introduced only recently, research work is going on and possible alternatives to this approach are being developed. The Federal Reserve, for instance, has proposed the precommitment approach. Its attractive features are that it incorporates a judgement on the effectiveness of a bank's risk management, puts greater emphasis on the incentives for a bank to avoid losses exceeding the limit it has predetermined, and reduces the regulatory burden. In my opinion, however, under this approach, too, a bank's choice of a capital commitment and the quality of its risk management system still need to be subject to supervisory review. And there are a number of other issues that are as yet unsolved—for example, comparability across firms given that the choice of the precommitment is subjective, the role of public disclosure, and the supervisory penalties, which are critical to the viability of the approach. For these reasons, international supervisors will have to study the results of the New York Clearing House pilot study carefully.

Other Risks

Now, let me turn to the other risks. If one leaves aside the recent amendment with respect to market risks, it is true that the Capital Accord deals explicitly with credit risk only. Yet the Accord provides for a capital cushion for banks, which is meant to absorb more losses than just those due to credit risks. Therefore, if the capital standards for credit risk were to be redefined, an issue that cannot be avoided is how to go about treating the other risks. Awareness of, for instance, operational, legal, and reputational risks among banks is increasing. Some banks are already putting substantial effort into data collection and quantification of these risks. This is not surprising. Some new techniques, such as credit derivatives and securitization transactions, alleviate credit risk but increase operational and legal risks, while several cases of banks' getting into problems because of fraud-related incidents have led to an increased attention to reputational risk. Not surprisingly, then, the Basle Committee will also be considering the treatment of risks that are at present implicitly covered by the Accord, such as those just mentioned and possibly interest rate risk as well.

In this process, it will be important to distinguish between quantifiable and nonquantifiable risks and their respective supervisory treatments. More specifically, the Committee will have to consider whether it should stick to a single capital standard embracing all risks, including market risks, or adopt a system of capital standards for particular risks—that is, the quantifiable ones—in combination with a supervisory review of the remaining risk categories. From a theoretical point of view, one capital standard might be preferable, since risks are not additive. Given the present state of knowledge, however, one all-encompassing standard for banking risks that takes account of their interdependencies still seems far away. As the trend thus far has been toward the development of separate models for the major quantifiable risks, a system of capital standards together with a supervisory review of other, nonquantifiable risks seems more likely.

Conclusion

The overall issue of this conference, particularly of this session, is where capital regulation is heading. In my address, I have argued that, since supervisory objectives are unchanged, a reduction in banks' capital adequacy would not be desirable. Alterations in the basic framework of the Capital Accord should not only take into account the developments in risk measurement techniques as increasingly applied by sophisticated banks, but should also reflect the worldwide application of the Accord. The Basle Committee is committed to maintaining the effectiveness of capital regulation and is willing to consider improvements, where possible. In this regard, the advances made by market participants in measuring and modeling credit and other risks are potentially significant. They should be carefully studied for their applicability to prudential purposes and might at some point be incorporated into capital regulation. But before we reach that stage, there are still formidable obstacles to be overcome.

Thank you.

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Risk Management: One Institution's Experience

Thomas G. Labrecque

I am very pleased to be part of this forward-looking conference on developments in capital regulation. Because the purpose of capital is to support risk, I decided to approach this session from the viewpoint of someone leading an institution that depends, for its success or failure, on how well it manages risk. My plan is to take you through my experiences at Chase Manhattan Corporation and to close with some thoughts on the implications of these experiences for capital regulation in the twenty-first century.

What I am going to describe to you is a dynamic approach to risk management, though not a perfect one. We continually make improvements, and we need to. Nevertheless, if I look back on the last six months—and the Asian crisis that has dominated this period—I would argue that never during this time did I feel that we had failed to understand the risks we were facing. In addition, I feel fairly confident that our regulators have a reasonably good understanding of the systems we use, and that, in the event of a crisis, these regulators would have access to daily information if they needed it.

Let me speak for a minute about market risk. There has been considerable discussion at this conference about the limitations of the value-at-risk approach to risk measurement. This approach is, of course, imperfect: it is built on the same kinds of assumptions that we all use routinely in our work.

In my view, value at risk is important, but it cannot stand alone. At Chase, we calculate our exposure to market risk by using both a value-at-risk system and a stress-test system. These systems apply to both the mark-to-market portfolio and the accrual portfolios. We use this combination of approaches to set limits on the risks we undertake and to assign capital to cover our exposures.

We came into 1997 with five stress-test scenarios built into our systems: the October 1987 stock market crash, the 1992 exchange rate mechanism crisis, the March 1994 bond market sell-off, the December 1994 peso crisis, and a hypothetical flight-to-quality scenario. We are currently expanding this set of scenarios to include four new prospective scenarios. In developing at least three of these four, we will have to use our judgment to predict how currencies, interest rates, and markets would be affected. By contrast, in the case of four of the five scenarios now in use, we already know the outcome.

Our risk limits in 1997, and certainly into early 1998, have been set by assessing our risks against these stress scenarios and the value-at-risk system. In fact, in the last year, the balance between the two approaches to risk

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management has probably moved more to the center. In any case, this combination of approaches has enabled us to manage market risk successfully.

Now, turning briefly to credit risk, let me review how our institution handles it. First, at Chase, we monitor individual transactions from several angles. We examine not only how the transaction is structured but also how it measures up against our lending standards. In this regard, an independent risk-rating process for applying and verifying risk ratings—one that is entirely independent of the units that actually carry out the bank's business—is an essential part of the credit review process at Chase. We also decide, at the time of the transaction, which credits we plan to hold in our portfolio and which we plan to sell into the market. Finally, we determine the contribution that each transaction makes to the overall risk of the portfolio because that contribution forms the basis of the capital allocation process.

Second, we identify and control credit risk by looking carefully at portfolio concentrations. Many of the crises of the 1980s—the real estate crisis, the savings and loan failures, the debt buildup in developing countries—can be traced to a failure to monitor portfolio concentrations. Recognizing these concentrations—for instance, by industry or by country—is a key element of understanding the true risks of the credit portfolio.

Institutions should track these concentrations as part of a dynamic approach to managing their portfolios. Dynamic portfolio management involves changing exposures to various risk categories through securitization, sell-downs, syndication, and other means, while continuing to serve your good clients.

At Chase, such dynamic management of concentrations in the portfolio is an important aspect of our overall risk management strategy. We've found that it brings results: for instance, because of our attention to portfolio concentrations, Chase did not have finance company risk in Korea in 1997. That was not an accident.

Third, we control risk by applying stress testing to our credit portfolio. Although the stress tests are not perfect, they do provide important guidance. For example, in the early stages of the Asian crisis, we ran a simulation in which we took the Asian segment of our portfolio and lowered the ratings of every credit by two grades. Then, by using historical data on nonperforming credits and charge-offs, we estimated how much of our Asian portfolio, in a two-grade drop, would be identified as nonperforming and how much would be charged off. Again, although the stress-testing approach has its limits, it was helpful in assessing our institutional risks.

A fourth way in which we manage credit risk is to review our customers on a real-time basis. It is especially important in an environment of crisis—such as the current financial turmoil in Asia—to look at every customer carefully. In this way, we have an evolving customer-by-customer view of our risk exposures, as well as an evolving stress-test view of our risks.

Moving on, let's consider how institutions can manage operating risks. Anyone who has been in this business as long as I have—and it is probably longer than you imagine—knows that payments system operating risks are crucial. Institutions must pay attention to the condition of their counterparties and to changes in the patterns of clearing activity. They should also regularly review the suitability of their intraday bilateral limits. In this regard, I would argue that the world's clearing systems and, most important, the New York Clearing House and the Clearing House Interbank Payments System {CHIPS} have worked with incredible efficiency and effectiveness to manage the operating risks that have arisen during the last six months.

Now, let's turn our attention to management oversight. Considerable responsibility for the sound operation of an institution rests with the management. Having a range of risk-monitoring systems is important, but if the findings of these systems are not relayed to management, then the systems will be of limited use. At Chase, market risk information is made available daily—not only to the traders but also to managers at the highest levels—the business manager, the head of capital markets, Walter Shipley (chairman and chief executive officer of Chase), and me. These daily reports are used to assess current risk control strategies and to develop an appropriate limit structure for the institution.

Similarly, information relating to credit risk goes to the business manager, to the head of the global division, to the corporate credit policy division, and to Walter and me. Information bearing on operating risk and payments system risk is reviewed by the payments system manager, the head of Chase Technology Services, the head of credit for institutional clients, and Walter and me.

In addition to reviewing the risk estimates provided by the business units, the senior officers of an institution also need an independent risk management unit. At Chase, this group runs the models and the management information systems, tests the models, works on the theory underlying the models, and gives us an entirely independent view of what we are doing every day.

As part of our approach to risk control, Walter and I routinely begin the week with two meetings: one is to review market risk, and the other is to assess credit and underwriting risk as well as current developments. Because of the events in Asia in recent months, we have held these meetings even more frequently—in fact, on a daily basis during some periods. In addition, each night we have reports on every market risk item on our desks.

The careful identification and analysis of risk are, however, only useful insofar as they lead to a capital allocation system that recognizes different degrees of risk and includes all elements of risk. At Chase, each business is allocated capital on the basis of the different types of risk it assumes—market risk, credit risk, and operating risk—and for the good will and other intangible assets it creates. Finally, we have added to these capital allocations a balance sheet tax for assets and for stand-by letters of credit—two measures that have not proved entirely popular.

The rationale for our procedures is that once we have characterized our risks, we want to make sure that we have allocated capital in accordance with these risks. In addition, we want to make sure that the returns we get from our businesses are commensurate with the risks we are actually taking.

What are the implications of our experience for regulators? First, it would be unwise to develop regulations that place inflexible restrictions on detailed aspects of our businesses. Banking is a very dynamic business, and regulation must be flexible enough to fit the institutions that are being examined.

Second, regulators should be very comfortable with the risk models used by each bank. In evaluating an internal model, regulators should adopt four criteria: Does the model closely mirror the markets? Is the complexity of the model (or of the combination of models used by the bank) commensurate with the institution's business and level of complexity? Does the model truly differentiate among various degrees of risk? Can the model be adapted to accommodate new products and new business, and, if so, is the review process for new products and services a sound one?

Third, regulators should examine an institution's capital allocation system for how closely it mimics markets and how well it differentiates risk.

If regulators follow these suggestions, then it should be easy to determine whether institutions are successfully managing their exposures or exceeding their risk limits. It should also be easy to check the returns on the risk-adjusted capital applied.

In closing, I would like to return for a moment to a theme raised in the conference's keynote address. Alan Greenspan remarked that our major banks use the probability of insolvency as the measure of institutional soundness for their internal risk assessments. It might be helpful, then, to identify some early warning signals of insolvency. In this connection, I recommend that supervisors monitor more carefully the level of subordinated debt issued by banks. Under what market conditions is the debt issued? How is the debt priced? How does the market react to the issue? How does the issue subsequently trade? At Chase, we are already attempting to implement this kind of review with our clients.

Another early warning signal might become available with the adoption of private-sector deposit insurance. I have thought long and hard about this issue over the years and can make a good case for private-sector deposit insurance. I would argue that if an institution were to buy commercially the first 5 percent of its insurance coverage on deposits (in the United States, this would mean that the Federal Deposit Insurance Corporation would be responsible for the remaining 95 percent), observers could learn a great deal about the soundness of that institution from the pricing of the insurance.

What I have given you today is the view of a practitioner, one who seeks to identify and control risks that could undermine the first-class institution he manages. My experience suggests that regulators should seek dynamic, rather than static, solutions to the problems of risk management and capital adequacy—solutions that reflect the diversity of the regulated institutions and the rapid changes in the structure, products, and risk control practices of the financial industry. If regulators look carefully at the risks assumed by each institution and the models each institution uses to calculate its exposure, then I am confident that they can determine the right capital positions.

Thank you all very much.

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