May, 1998

Executive Summary

Credit Risk Models at Major U.S. Banking Institutions: Current State of the Art and Implications for Assessments of Capital Adequacy

Federal Reserve System Task Force on Internal Credit Risk Models

I. Background and Conclusions

Supervisors have long recognized two 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 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 (e.g., 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 the banking book.

With the formal RBC ratios rendered less useful, judgmental assessments of capital adequacy through the examination process necessarily have assumed heightened importance. Yet, this process, too, has become more problematic as regulatory capital arbitrage has made credit risk positions less transparent. While examination assessments of capital adequacy normally attempt to adjust reported capital ratios for shortfalls in loan loss reserves relative to <u>expected</u> future charge-offs, examiners' tools are limited in their ability to deal effectively with <u>credit risk</u> --

measured as the uncertainty of future credit losses around their expected levels.

In contrast to the Accord's one-size-fits-all approach to RBC, many of the largest banks have developed sophisticated methods for quantifying and internally allocating capital against credit risks. Analogous to trading account VaR models, internal credit risk models are used in estimating the *economic* capital needed to support a bank's credit activities. These economic capital allocations, in turn, are used in measuring the *risk-adjusted* performance of various activities, determining risk-based prices for credit services, and setting portfolio exposure and concentration limits. Besides their applications in economic capital allocation systems, credit risk models also are used by some banks in day-to-day portfolio risk management.

The System Task Force on Internal Credit Risk Models was created to assess potential uses of banks' internal credit risk and capital allocation models within the supervisory process. This report surveys the state-of-the-art in the design and implementation of credit risk models,[1] and presents preliminary conclusions regarding potential regulatory and supervisory uses of these models.

Briefly, the Task Force's preliminary conclusions are summarized below. With regard to formal regulatory capital requirements for credit risk, the Task Force believes that while improvements in credit risk modeling are occurring rapidly, a number of important challenges must be addressed before adopting an internal models approach to RBC for the *banking book* -- as a *replacement* for the Basle Accord for large, complex banking organizations. Among these issues are (a) supervisory determination of "acceptable" conceptual framework(s) (e.g., the framework for defining "credit losses"), (b) difficulties in calibrating key model parameters owing to data limitations, and (c) a need for more systematic and comprehensive approaches to model validation, including explicit treatment of model uncertainty/instability. While similar issues are relevant to VaR models for the *trading account*, the magnitude of these concerns is much greater with respect to credit risk models for the *banking book.*[2]

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[1] The study involved extensive discussions with twelve banking organizations, two nonbank securities firms, and numerous consultants and practitioners.

[2] A secondary concern relates to the need to address non-credit and non-market risks (generally referred to collectively as "operating risks") within any formal internal models

Given the ongoing progress in credit risk modeling techniques, it is conceivable that further improvements could redress many, if not most, of the concerns raised by the Task Force. However, in the interim, as traditional techniques for assessing capital adequacy are rapidly becoming outmoded, improved supervisory methods are needed if capital-based prudential policies are to remain viable even over the shorter term. Because the most accurate information regarding risks is likely to reside within a bank's own internal risk measurement and management systems, supervisors should utilize this information to the extent possible.

To this end, this report outlines several possible near-term uses of internal credit risk models that, while not a full replacement for the Accord, could nevertheless enhance current prudential policies. Specifically, these models may be useful in two roles: (1) the development of specific and practical *examination* guidance for assessing the capital adequacy of large, complex banks; and (2) the setting of *regulatory* capital requirements against *selected* instruments that have largely evolved subsequent to the adoption of the Accord, such as credit enhancements supporting securitization programs.

II. Internal Capital Allocation Systems: An Overview

Many large banks have developed sophisticated internal systems for allocating capital against the risks they have undertaken. While such systems typically encompass the primary forms of risk faced by banks (credit, market, and operating risks), the principal focus of the Task Force report is credit risk.

Underpinning all economic capital allocation systems are implicit or explicit estimates of the probability density function of credit losses ("PDF") for a bank. Exhibit 1 illustrates such a PDF. Although the precise definition of "credit loss" tends to vary across banks (see below), a risky portfolio, loosely speaking, is one whose PDF has a relatively long and fat tail -- that is, where there is a relatively high likelihood (compared with PDFs that have thin tails) that actual losses will be substantially higher than expected losses.

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approach to regulatory capital requirements. The economic capital allocated against operating risks at many large banks is substantial. Thus, unless the Accord were to be modified to consider operating risks more directly, an internal models approach to credit risk *per se* could substantially understate banks' overall capital needs.

For purposes of internal decision making, banks generally "collapse" the estimated PDF into a single metric, termed the "economic capital" allocation for credit risk. This process is analogous to the VaR methods used in allocating economic capital against market risks. Specifically, the economic capital allocation is determined (in theory) so that the probability of unexpected credit losses exhausting economic capital is less than some targeted level. For instance, the level of economic capital may be set to achieve a 0.03 percent estimated probability over a one year horizon that unexpected credit losses would exceed this level, thereby causing insolvency.[3] The target insolvency rate usually is chosen to be consistent with the bank's desired credit rating for its liabilities -- if the desired credit rating is AA, the target insolvency rate might be set at the historical one-year default rate for AA-rated corporate bonds (about 3 basis points).

Within economic capital allocation systems, a critical distinction is made between *expected* credit losses and the *uncertainty* of credit losses (i.e., *credit risk).* These 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. In Exhibit 1, therefore, the area under the PDF to the left of expected losses should be covered by the loan loss reserve, while the bank's required economic capital is the amount of equity over and above expected losses necessary to achieve the target insolvency rate. Under this framework, a bank would consider itself to be undercapitalized if its tangible equity (adjusted for any over- or under-reserving relative to expected losses) was less than its required economic capital.

Economic capital allocation systems, and credit risk models more generally, tend to be used in two broad applications: (a) the measurement of risk-adjusted profits, and (b) the management of portfolio risks. An activity's risk-adjusted profits typically are measured by adjusting traditional cost-accounting measures of net income for the opportunity cost of the equity needed to support that activity (i.e., its economic capital allocation).[4] Specifically, risk-adjusted

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[3] The economic capital allocation for a sub-portfolio of credit instruments would be calculated as the difference between the portfolio's economic capital allocations with and without the inclusion of those particular assets.

[4] For purposes of calculating risk-adjusted profits, economic capital reflects all forms of risk -- credit, market, and operating risk. In practice, the total economic capital for an activity is

profits are calculated by imputing to each activity its allocated cost of equity capital (defined as the activity's allocated economic capital *times* the bank's ROE target or hurdle rate). In this fashion, risk-adjusted profits for various activities can be placed on an apples-to-apples basis, and managers can make informed decisions about how to allocate scarce resources -- that is, which activities to increase in size or scope, which to cut back, and which to eliminate.

The second broad application is risk management. When setting the price on a proposed new loan facility, it is now fairly common for a banker first to determine the break-even interest rate covering the loan's *expected losses* and an appropriate margin for *credit risk* -- determined so that the expected rate of return on the capital allocated to the loan (the Risk-Adjusted Return on Capital, or RAROC) achieves the bank's hurdle rate. Economic capital allocations also are used increasingly in setting portfolio concentration limits for individual customers, industrial sectors, and geographic regions. In addition, a few institutions employ credit risk models to improve their estimated risk-return profile through active day-to-day portfolio management involving the buying or selling of credit exposures in the secondary loan market or the credit derivatives market.

III. Broad Approaches to Risk Measurement: Aggregative vs. Structural Models

As noted above, internal capital allocations against credit risk are determined fundamentally by two factors -- a bank's appetite for risk taking, as reflected in its target insolvency rate, and its estimated PDF for credit losses. The chief focus of the Task Force report is on the risk modeling practices used in estimating PDFs. Among major U.S. banks, there is considerable diversity in these practices. To provide a taxonomy for later discussions, the Task Force has divided risk measurement approaches into two broad categories: "aggregative" models and "structural" models, illustrated in Exhibit 2.

A. Aggregative Risk Models. Aggregative models typically are "top-down" approaches that attempt to infer the "total risk" (i.e., the sum of credit, market, and operating risks) of a broadly defined business or product line from the capital ratios of peers or from the historical cash flows associated with that activity. Peer group or "market comparables" analysis attempts to estimate the capital that would be needed to achieve a hypothetical "target" credit rating for a

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generally calculated as the simple summation of the separate allocations for each type of risk.

given activity (as if operated on a stand-alone basis) from the capitalization rates of competitors engaged in that activity. The other major aggregative technique, historical cash flow analysis, attempts to estimate an activity's total risk from the volatility of its historical cash flows. Typically, the economic capital allocation for a business line is set simply as some multiple of the observed standard deviation of historical cash flows from that business line within the bank.

Among banks, aggregative models tend to be used mainly for assessing the performance of broad business or product lines, for making large-scale strategic business decisions (such as acquisitions or divestitures), or for validating structural risk models, rather than for day-to-day investment and risk management purposes. In part, this pattern of usage reflects the relative insensitivity of aggregative models to variations in portfolio composition within the business lines that are separately analyzed. Peer analysis, for example, may be misleading if the credit quality of a bank's portfolio differs significantly from that of its competitors. Similarly, the historical cash flow approach may be inappropriate if the composition of the current portfolio (e.g., its sectoral make-up or the credit quality of customers) is substantially different from that historically.

B. Structural Risk Models. Most banks estimate their total portfolio risk through structural modeling approaches in which separate models are constructed for credit, market, and operating risks. With respect to the modeling of credit risk, banks often employ "top-down" approaches in certain lines of business (e.g., consumer or small business lending), and "bottom-up" approaches in others (e.g., large corporate customers). For consumer and small business customers, a bank may assume that certain broad classes of loans (e.g., credit cards) are more or less homogeneous, and that the associated PDF can be estimated from the volatility of the bank's historical net charge-offs on such credits. Such top-down credit risk models generally are vulnerable to the same concerns as top-down aggregative models -- the current portfolio quality and composition may differ substantially from those historically.

Within banks' large corporate businesses, credit risk normally is modeled using "bottom-up" approaches. That is, the bank attempts to identify and model risk at the level of each individual credit facility (e.g., a loan or a line of credit) based on explicit evaluations of the financial condition of that customer. To measure risk at higher levels of consolidation, such as for a customer relationship or a line of business, these individual risk estimates are summed *taking*

into account diversification effects. Thus, within bottom-up models, variations in credit quality across customers and other portfolio compositional effects are considered explicitly. A principal focus of the Task Force report is the design and implementation of such "bottom-up" credit risk models. It is in this arena that the industry is expending significant effort and is making the greatest conceptual and practical advances in credit risk modeling.

IV. "Bottom-up" Credit Risk Models: Modeling Issues

As shown in Exhibit 2, structural models that measure credit risk in a "bottom-up" method entail several specific steps. Much of the Task Force report deals with these critical and often subjective choices, which can significantly affect the final internal capital allocations. This section provides a sense of the most important modeling issues, as background to the policy-related discussion in section V. Nevertheless, this material is not essential to the policy discussion, and can be skipped if so desired.

A. Internal credit rating systems. Within nearly all bottom-up credit risk models, a credit instrument's "internal credit rating" is used to represent its probability of default. Furthermore, a risk position's rating, in most banks, is sufficient to determine the internal capital assigned to the position by the credit risk model. The vast majority of the top-50 U.S. banks assign a credit grade to each large- and middle-market customer, as well as to each customer's separate credit facilities -- defined to include all on- and off-balance sheet credit exposures. Internal credit rating systems are designed to differentiate the credit quality of borrowers much more finely than under the five-point grading scale used by bank examiners (i.e., pass, specially mentioned, sub-standard, doubtful, and loss). A typical internal rating system might include six "pass" grades plus the four "criticized" grades, while the most detailed system might include 18 or more separate pass grades.

For risk modeling purposes, a bank would normally relate its credit grades to some external standard, such as S&P's corporate bond ratings. Thus, a grade 1 loan may be deemed roughly equivalent to an S&P bond rating from AA to AAA, a grade-2 loan equivalent to a bond rating of single-A, and so on. Given this concordance, the probability of a credit instrument defaulting over some horizon is usually inferred from published data on the historical default rates of similarly rated corporate bonds.

Since most bottom-up credit risk models are based on the asset rating process, a critical issue is the extent to which the bank's internal rating process sufficiently describes differences in risk characteristics among classes of assets or between individual risk positions. For example, a bank's rating process may result in 70 percent or more of commercial loans being lumped into only two "pass" rating categories, despite the fact that the bank may have 6 or more pass rating categories. Also, since a rating is meant to reflect *only* a position's default probability (or in some cases, its expected loss rate), the rating may be inconclusive in describing other important elements of the position's contribution to portfolio risk. For example, a corporate bond of a given rating may exhibit a very much lower loss-given-default and loss variance than would a subordinated securitization tranche with a similar rating. This is because the subordinated tranche is effectively "levered" and will absorb a disproportionate share, in some cases virtually all, of the credit losses on the underlying asset pool being securitized.

B. 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 the study refers to as either a Default-Mode paradigm or a Mark-To-Market paradigm for defining credit losses.

1) Default-Mode Paradigm. At present, the default-mode (or DM) 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: non-default 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 (or MTM) 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 the valuing the loan would depend on the instrument's credit rating.[5]

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 *also* could 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 U.S. 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 *ad hoc*, so it is difficult to assess their effectiveness.

C. 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 draw-down rates tend to increase as a customer's credit quality deteriorates. As observed in

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[5] While few banks currently use the MTM framework outside their trading accounts, many practitioners believe the industry is likely to evolve from largely DM-based risk models for the banking book to the more general MTM-based models over the near term.

connection with the recent turmoil in foreign exchange markets, credit-related optionality also arises in derivative 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 ten-fold. In some cases these differences reflect modeling assumptions that 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 the customer's credit quality. Going forward, the treatment of credit-related optionality appears to be a priority item, both for bank risk modelers and their supervisors.

D. Model calibration. Perhaps the most difficult aspect of credit risk modeling is the calibration of model parameters. To illustrate this process, recall 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 (1) the expected probability of default for each loan; (2) the probability distribution for each loan's loss-rate-given-default; and (3) 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.

The study analyzes many 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 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.

E. Model validation. Given the difficulties associated with calibrating credit risk models, there is a clear 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. Due to insufficient data for out-of-sample testing, banks generally don't 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. 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 the Task Force is 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. Regardless of how formal RBC standards evolve over time, within the relatively 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, the Task Force believes such efforts should take full advantage of banks' own internal risk management systems -- which generally reflect the most accurate information about their credit exposures -- and on encouraging improvements to these systems over time.

The Task Force is considering several possibilities for utilizing internal credit risk models within prudential capital policies. These potential applications may be divided into two main areas: (a) the setting of RBC requirements for *selected* credit instruments, and (b) the development of enhanced examination guidance on assessing the capital adequacy of large, complex banks.

A. Selective Use in Setting 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 credit 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 possible 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. To address various inconsistencies in the current RBC treatments of credit enhancements supporting securitization programs, the NPR proposes setting RBC requirements for such instruments on the basis of credit ratings for these positions obtained from one or more accredited rating agencies. A natural refinement of this approach 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 can not 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 and confidence in such models, and for considering possible expanded regulatory capital applications over time.

B. Improved Examination Guidance. Apart from their possible use in setting formal RBC standards, the inputs and outputs of banks' internal credit risk models could enhance assessments of bank capital adequacy through the examination process. For instance, examiners could use a bank's own internal credit rating systems to assess the relative riskiness of a bank's pass (or non-classified) assets. Provided that a concordance schedule could be developed that appropriately translated each bank's rating "buckets" into a common standard (perhaps paralleling S&P's or Moody's rating systems), examiners also could assess how the credit quality of a bank's portfolio compared with that of its large peers. This information could be used in much the same way that senior bank managers now use their own internal credit rating reports to evaluate the adequacy of the loan loss reserve and changes in a portfolio's credit quality over time.

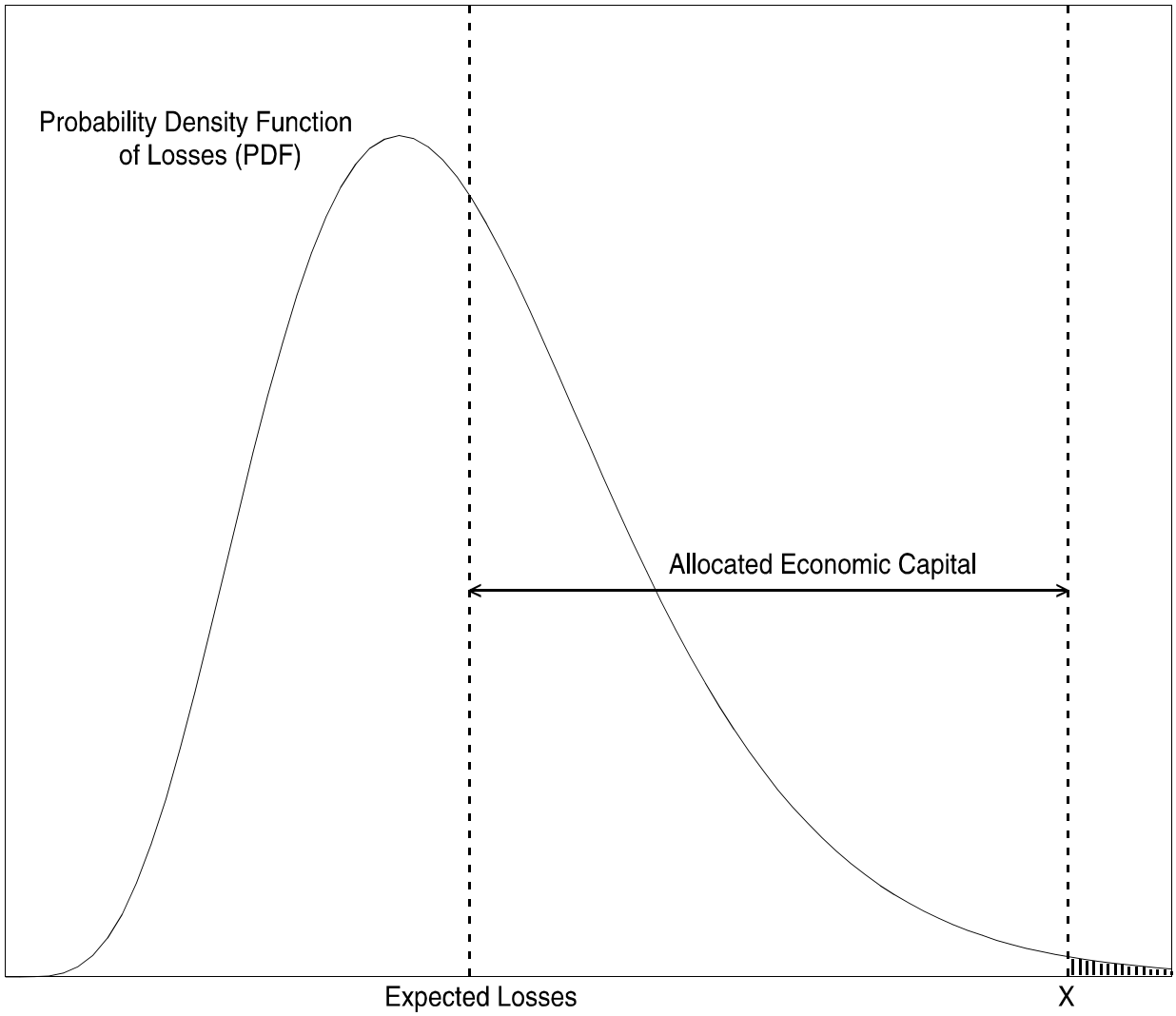
More broadly, it may be possible for supervisors to effectively use the risk measurements and capital allocations generated by the banks' credit risk models to assess the quality of a bank's risk measurement systems and overall capital adequacy. To give one example, in contrast to the current RBC framework, typical internal capital allocations for unsecured term loans often range from 1 percent or less for AAA-rated loans to more than 30 percent against loans classified as "doubtful" -- *not* counting any reserves for expected future charge-offs. Examiners might 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). 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 dealing with internal credit risk models would provide several useful benefits. Such an initiative would encourage further model development by banks, and would help ensure that supervisors remained abreast of ongoing improvements in risk modeling practices. In addition, both supervisors and the banking industry would benefit from the development of sound practice guidance on the design, implementation, and application of internal credit risk models and capital allocation systems within large, complex banking organizations. 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. Such efforts also would likely stimulate constructive discussions among supervisors and bankers on ways to improve credit risk measurement and management practices.

Exhibit 1

Relationship Between PDF and Allocated Economic Capital



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

Exhibit 2
Overview of Risk Measurement Systems