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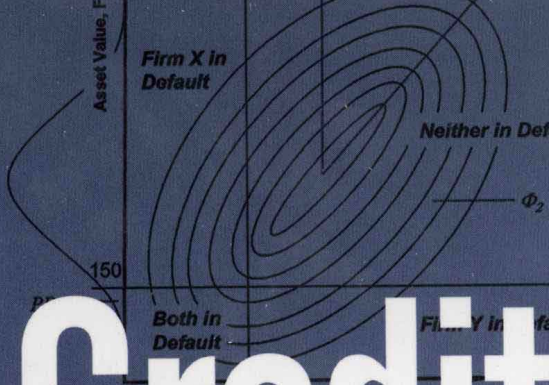
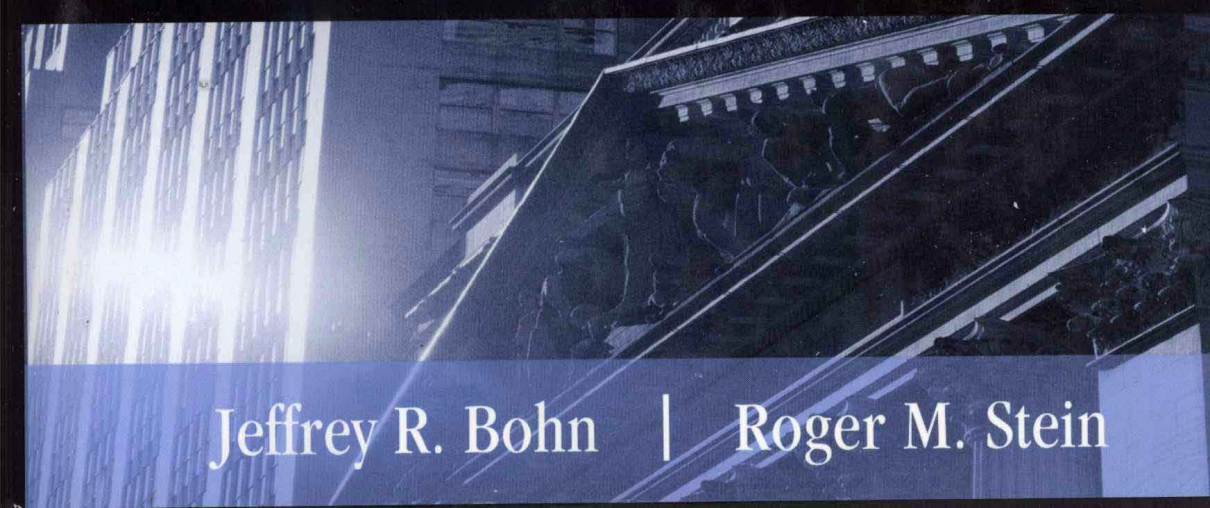


Active Credit Portfolio Management in Practice

"... A masterful collection of accessible and practical guidance
—From the Foreword by Darrell Duffie



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Active Credit Portfolio Management in Practice

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WILEY

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For
Brenda, Brittany, and Ian
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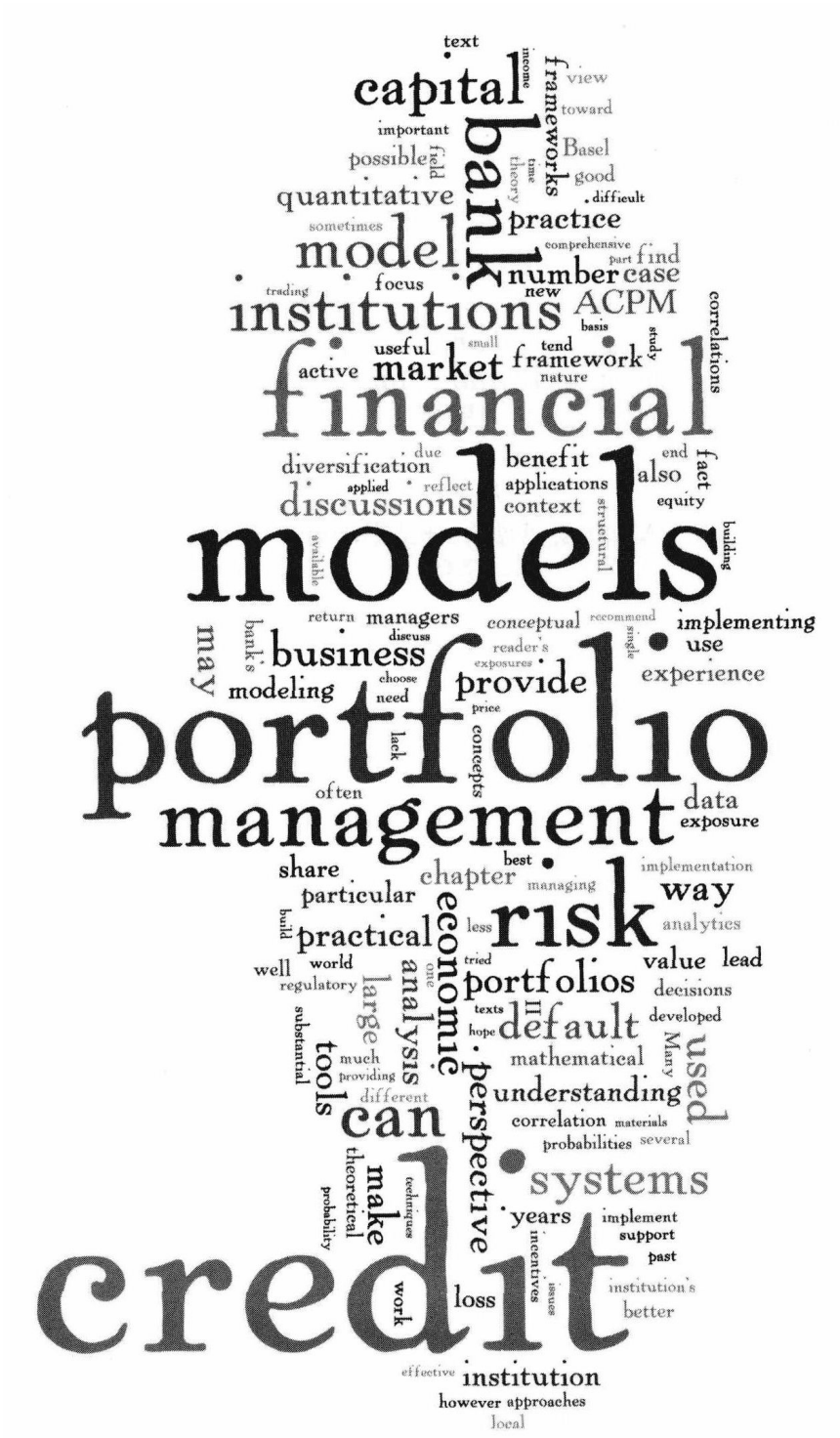
For
Michal, Ariel, and Tamir
—RMS



Foreword

Jeff Bohn and Roger Stein are ideally positioned to provide us with this artful treatment of credit risk modeling. The book is a masterful collection of accessible and practical guidance placed on strong conceptual foundations. As leading entrepreneurs and practitioners in the quantification of credit risk, and at the same time among the top scholars writing widely on the topic, Jeff and Roger have been riding a wave of exceptional changes in credit markets. The design of many new financial products, the explosive growth of trading in credit derivatives, a major change in bank capital requirements for credit risk, and a surge of new theoretical and empirical research have combined to make this the place to be among all areas of financial markets for the decade up to 2007. And then came the serious credit crisis in which we find ourselves. Roger and Jeff have been through it all.

The credit crisis of 2007–2008 has set us back on our heels. Issuance of structured credit products, not just in the subprime area, is down dramatically, just as issuance of collateralized mortgage obligations fell over a cliff after the 1994 blowout of David Askins' Granite Fund. Numerous regulators, commercial banks, rating agencies, bond insurers, and buy-side investors are under exceptional scrutiny for their risk management and other failures. It is time to take stock of what we as modelers could have done better. In this excellent book, Jeff and Roger provide state-of-the-art guidance on how to measure credit risk, borrower by borrower and also at the portfolio level.

In my opinion, products were designed, rated, priced, and risk-managed with too much confidence in our ability to reasonably capture default correlation using the current generation of models and methods of data analysis. Had we better models for default correlation, some of the overhanging risks would have been better understood and avoided. Alternatively, with at least a better appreciation of the weaknesses of the models that we have been using, the tide of issuance of relatively complex products might have been stemmed somewhat. Would someone in any case have suffered the ultimate losses on subprime mortgage assets? Those losses were larger than they would have been without such a ready market for structured products,

offering credit spreads that might have been appropriate for the risks as measured, but not for the actual risks. Laying off those risks through a food chain of structured products reduced the incentives of the direct lenders and servicers of the underlying loans to screen and monitor the borrowers and to limit credit appropriately.

The failure of our current generation of models to better measure default correlation is not restricted to products backed by subprime credit. For example, the market for collateralized debt obligations (CDOs) backed by corporate debt is also ripe for a crisis of confidence. It would take only a somewhat surprising string of corporate downgrades or defaults for investors, already spooked by the subprime crisis, to reprice bespoke corporate-debt CDOs in a manner that would make the distortions in this market during the events surrounding the GM downgrade of May 2005 seem like a mere hiccup.

Indeed, by mid-2008 the issuance of bank-loan collateralized loan obligations (CLOs) has fallen off significantly in parallel with the virtual disappearance of issuance of subprime-backed CDOs.

In concept, structured credit products like CDOs are well suited to transferring credit risk away from banks and other credit intermediaries, and placing it in the hands of buy-and-hold investors who are less crucial to the provision of liquidity to financial markets. Those investors can indeed be offered properly designed and rated products that are suited to their risk appetites and financial sophistication. Long-run institutional investors such as insurance companies, pension plans, and endowments can be rewarded with extra spreads for holding assets that are relatively illiquid, for they don't need as much liquidity and should not pay for what they don't need. For now, however, the well has been tainted.

Going forward, we need to pay more attention to the development and use of models with stronger conceptual foundations, fed by better and more relevant data. This excellent book by my long-valued colleagues, Jeff Bohn and Roger Stein, is a good place to start.

DARRELL DUFFIE
Lausanne
June 2008

Preface

Sen ri no michi mo ippo kara. *(Even the thousand mile road starts from a single step.)*

—Japanese Proverb

In theory there is no difference between theory and practice. In practice there is.

—Yogi Berra

Several years ago, a commercial banker asked one of us why he needed to calculate expected loss for his loan portfolio since he didn't "expect" to lose anything. Shortly after this conversation, this banker's bank experienced an unprecedented default in its portfolio, and this default impacted the profitability of the bank. The bank quickly moved to introduce more quantitative analytics to manage its risk and the banker who hadn't expected any loss took early retirement.

Up until the past 10 years or so, calculating any portfolio level analytic, such as portfolio expected loss, was considered by many to be irrelevant to the executives driving the businesses at large financial institutions. Credit analysis consisted of qualitative characterization of a borrower's health coupled with a few financial ratios they saw as necessary to keep regulators happy. The world has changed.

Today credit analysis encompasses both qualitative and quantitative analysis. Most executives at large financial institutions expect to see analytics such as portfolio expected loss. They also request estimates of unexpected loss (also known as portfolio volatility) and the likelihood of extreme losses (tail risk) that may impair the institution's ability to run its business. The most recent credit crisis notwithstanding, it is a rare financial executive who does not now require a quantitative characterization of the overall risk faced by that institution. Financial institutions without the infrastructure to measure, monitor, and manage their credit exposure run the risk of sudden demise or possible takeover.

New strategies and instruments facilitate active diversification of a credit portfolio to better weather the current crisis and prepare for the next one.

Financial institutions are in the midst of an unprecedented shift in the way they are managed and evaluated. In this book, we present a collection of ideas, models, and techniques for understanding and interpreting these changes.

With the rapid growth in quantitative credit risk management, we found in writing this book that many of our colleagues in academia and banking have also been busy writing. In fact, a number of excellent texts have been written in the past several years that provide a rich theoretical context for a diversity of credit models. Our goal in writing this book is perhaps far more modest but specific. We have tried to produce a practical text that presents a number of compelling ideas and descriptions in a way that makes clear how these techniques can be applied *in practice*. We have framed most of the discussions in the context of real business applications requiring the implementation of tools to support credit trading, active credit portfolio management (ACPM), and management of economic capital. When useful, we have included key derivations in the context of our model descriptions; however, more detailed understanding of the mathematics behind many of these models will require referencing one of the books or papers that we include in the References list.

Thus, our goal has been to write a book that provides substantial insight into our experiences in implementing credit-risk models and methodologies from the trenches, without necessarily providing a full complement of rigorous mathematical results in each case. By the same token, however, this is not intended to be a recipe book on financial engineering or a statistics manual. We have tried to limit our presentation of detailed algorithms to those that are not widely covered in other sources. So, for example, we do not discuss how to implement algorithms such as loess, the bootstrap, or Newton-Raphson, but do provide details on how to calibrate PD models to ratings from a number of different perspectives, or how to estimate asset volatility effectively for a structural model.

As in many endeavors, we will almost certainly disappoint some readers, but hope (in expectation) to generally satisfy most. There is a joke about three statisticians who go hunting. They spot a bird overhead in the distance. The first statistician steps up, fires, and shoots 50 feet in front of the bird. The second steps up, fires, and shoots 50 feet behind the bird. The third steps up, looks through his binoculars and declares, "We got him."

We hope to do better than this!

To illustrate the practical challenges of using these models, we provide specific advice on various details of implementation, which we include in boxes throughout the text. We have also included a composite case study based on our experience working with financial firms building and managing credit, capital, and portfolio management systems. This case study and the practical examples throughout the book reflect the synthesis of our collective

experience from interacting with hundreds of banks and financial institutions over the past 20 years.

This approach mirrors the evolution of credit models, tools, and systems in recent years. The models and analytics have become more standardized and more widely understood. Many of the good books we mention are available to take readers deep into the derivations of these models (see Duffie and Singleton 2003; Lando 2004; and Schonbucher 2003 for more detailed and comprehensive descriptions of the literature and derivation of credit models). The conceptual foundation of why these tools should be used has become more widely accepted. This was not always the case; however, the wave of research in credit modeling over the past decade and a half, led by these authors and their academic colleagues, has resulted in a body of theoretical work that is far better developed than it has ever been.

In industry, we now find that the bigger practical challenge is implementing systems that actually *make use* of these new analytics and tools in a way that realizes their conceptual promise. As many practitioners have discovered as they begin to implement credit analytic systems and procedures within financial firms, the size of the gap between theory and practice can be large. Our goal is to help fill this gap.

The broad concepts underlying ACPM and its associated economic capital management approaches are easy to enumerate and easy to explain. We consider five important ideas to be our catalysts for the value-enhancing characteristics of the models and frameworks we describe in this book:

1. Default probabilities are dynamic and, for many asset classes, can be accurately estimated.
2. Credit exposure correlations and loss given default can be estimated (though with considerably less precision than default probabilities), leading to a quantification of a credit portfolio's risk.
3. Active management of credit portfolios can lead to higher return per unit of this quantified portfolio risk.
4. Economic capital is a scarce resource for a financial institution attempting to build a profitable business and is determined by a target credit quality.
5. Managing a portfolio of credit-risky instruments and managing a portfolio of business franchises require different business models, managers, and cultures to be successful. Transfer pricing of risk is an efficient tool for separating incentives associated with the credit portfolio and the portfolio of businesses.

In this book, we discuss the approaches to measuring quantities such as default probabilities and correlations that we have found most useful, and we attempt to provide insight as to how they can be used to facilitate active

portfolio management and economic capital allocation. Along the way we will explore related themes such as quantitative risk management, valuation, and credit trading. The dynamic nature of default probabilities (from peak to trough of the credit cycle, typical default probabilities may change by a factor of five or six), coupled with the empirical fact that cross-sectionally they can range over a large spectrum (the range is typically one basis point to thousands of basis points) creates an opportunity in which implementation of powerful default probability models will lead to substantial savings as a financial institution minimizes its bad lending decisions.

Many financial institutions choose to implement single-obligor risk management systems only. Somehow, in practice, focusing on the stories behind each name tends to trump a less personal portfolio perspective. While we believe that any effort to implement best-practice systems is a positive step (even if that system focuses just on quantifying single-obligor risk), we will repeatedly emphasize our view that a portfolio view of credit is ultimately the best and most prudent way to manage a financial institution exposed to credit risk. Said another way, it is hard to make money (and avoid large losses) consistently by only focusing on single-name credit decisions without reference back to a portfolio.

The emphasis on the portfolio perspective of credit arises from the nature of the credit return distribution. Any quantitative analysis of credit begins with the skewed, non-normal return distributions typical of both individual credit exposures and portfolios of those exposures. (While correlations of credit exposures tend to be lower than the correlations of other types of securities such as equity, when coupled with the asymmetric payoff of credit exposures, they can create substantial skewness in the loss distributions of these assets.) Herein lies the source of diversification benefits from large portfolios. A holder of a credit portfolio continues to benefit in terms of diversification as more small and minimally correlated exposures are added to the portfolio. With symmetric distributions such as those exhibited by equities, the incremental benefit of diversification is quite small once the portfolio is in the hundreds of names (some researchers argue incremental diversification benefit stops in the tens). In contrast, the probability of correlated extreme losses is small in credit portfolios, but not negligible and certainly not economically insignificant. Unlike an equity portfolio with a (fairly) symmetrical return distribution, a so-called fully diversified credit portfolio may still have substantial volatility due to this nondiversifiable component of its correlation structure.

Ironically, credit markets originate credit in a decidedly undiversified way. As a consequence, holding the (local) market-weighted portfolio of outstanding credit produces dangerously concentrated portfolios. These circumstances contrast with the equity market where the market-weighted

portfolio is well diversified. The implication is that while active management does not seem to produce much benefit for equity portfolios, it does produce substantial benefit for credit portfolios. This observation sets the stage for the importance of implementing systems, models, and tools to support active credit portfolio management.

However, although our knowledge and technical abilities regarding credit-risk quantification have expanded dramatically, there remain substantial hurdles. Paramount among these is the practical difficulty in estimating and validating correlation models, which are essential to effective portfolio management. In the case of single-obligor default risk modeling, we now often have enough data to draw conclusions about the performance of a model. (This was not always the case. As recently as a decade ago, default probability models were sold in terms of their conceptual coherence or anecdotal behavior. As more data became available, these conceptual discussions were backed up by the development of rigorous validation frameworks and techniques, which moved the discussions from model coherence to empirical performance.) In contrast, even today, we are still in the conceptual stage of understanding many correlation models. Partly due to the nature of correlations and partly due to a lack of data, often we cannot make strong statements about correlation models on the basis of rigorous validation. Nonetheless, correlations are an integral part of good portfolio models and we must often make do with the best tools that are available, augmented with judgment and experience.

Another practical difficulty in implementing active credit portfolio management has more to do with the psychology of lenders than the limitations of our mathematics. Financial institutions thrive on the creation of customer relationships, and executives love a good story. Shifting to a portfolio perspective often replaces some of the anecdotal discussions of industry structure, a company's product, and the personality of a CEO with reams of data presented in an abstract way. Executives at leading financial institutions understand the importance of portfolio-based decision making, but they and their staff still lean toward single-obligor analyses. While industry experience and common sense are crucial to using credit models wisely, they cannot generally, in and of themselves, form the basis of credit policies for complicated portfolios of correlated assets.

In our judgment, it is useful for organizations to segment the portfolio management function into a central group, while at the same time providing relationship managers with incentives to cross-sell services into their client base. In this way, the anecdote- and relationship-based approaches can still have relevance alongside those of the individuals with more of a quantitative bent who will migrate to the portfolio management function. The economic capital allocated to support the relationship business, which generates fee

income from selling financial products and services, can then be differentiated from the economic capital allocated to support the central management of the credit risk in the portfolio.

The portfolio perspective does not release a bank's management from the responsibility to stay vigilant as to the possibility of fraud and poor monitoring, which some have asserted were common in the run-up to the subprime difficulties witnessed in recent years. Rather, the portfolio perspective—informed by quantitative characterization of the return and risk profiles of a bank's portfolio—should be part of senior management's toolkit. Models serve the specific purpose of distilling information and reducing the level of complexity in understanding the return and risk of a portfolio exposure. Unfortunately, model output can sometimes become a crutch for managers unwilling to drill into the details of a transaction or portfolio strategy. This book is one attempt at demystifying key credit models so that more participants in the financial markets can better understand the underlying drivers of the risks to which they are exposed.

In a number of places in this book, we make a point of relating abstract financial theory to quantifiable financial costs and benefits that can be used for the purpose of better aligning incentives with share-value maximizing behavior. The result should be a more valuable financial institution.

WHY ACTIVE CREDIT PORTFOLIO MANAGEMENT?

Several trends in the financial markets reflect the growing recognition of the benefit of active credit portfolio management (ACPM). There are a number of reasons for this. First, analyses of past banking crises highlight one major common source of bank failures: too much portfolio concentration. If a bank develops a strong business in a particular area, and if it does its job well, over time it will generate concentrated exposure to this area as the bank and clients seek each other out in these areas of specialization. In a global market, the correlations may be less apparent, but no less dangerous. Actively managing a portfolio mitigates this concentration risk to the extent possible.

Second, the development of credit derivatives such as credit default swaps (CDSs) and synthetic collateralized debt obligations (CDOs) has presented a new set of tools for managing diversification. Recent difficulties in the structured finance market have dented some of the enthusiasm for CDO and collateralized loan obligation (CLO) structures. The broader credit crisis of 2007 and 2008 has cast doubt on the usefulness of CDSs. Nonetheless, when used for hedging, rather than as investment vehicles in and of themselves (particularly when the investment is highly levered), users of

synthetic structures and credit derivatives can improve diversification relatively cheaply compared to transacting in the underlying assets individually. However, along with these powerful instruments comes responsibility. Participants in this market for credit derivatives must continue to work on building a robust and viable market with natural buyers and sellers trading in all market conditions and at reasonable leverage levels. Much of the analysis that benefits portfolio analysis can also be applied to these synthetic versions of credit portfolios. On the other hand, when these instruments are used to "take a position" on the market directly, rather than to hedge an existing position, they can actually increase concentration and can work against prudent portfolio management practice.

Third, financial institutions that manage their credit portfolios appear historically to weather economic downturns more effectively. One of the more recent economic downturns in the United States, following the dot-com bust at the start of the new millennium, highlighted the resilience of U.S. commercial banks with diversified portfolios. This recession was marked by a lack of bank failures, due in no small part to how credit exposure was managed. More recent banking difficulties have been partly a consequence of disappearing liquidity in the financial markets; however, many of the larger failures were also a consequence of large portfolios with concentrated exposure to the U.S. real estate market. One of the authors has heard from some credit portfolio managers that they were never given the opportunity to manage credit exposure that entered their institution's portfolio in the form of tranches in structures with mortgages as collateral. These same managers have successfully minimized losses in portfolios of large corporate loans that have historically been the source of concentration risk in bank portfolios. Hopefully, more financial institutions will begin to manage all of their credit exposures from a portfolio perspective (not just large corporate exposure).

Despite the advances in managing credit portfolios, the recent difficulties triggered by the subprime crisis in the United States suggests that many institutions still have work to do in terms of managing their exposure to liquidity risk that arises when too many market participants end up on the same side of every trade. In the end, however, even the best risk management systems are still only a component of a business strategy. Management still must take firm control of the institution and rely actively on both risk control systems and sound business judgment to provide guidance.

Ultimately, the emphasis on ACPM derives from a premise that underlies our thinking with respect to banking: Bank managers should be making decisions to maximize the value of the bank's equity shares. This emphasis by bank managers will result in substantially different portfolios than those at banks whose managers focus on maximizing the amount of assets held in the bank's portfolio.

That is, a large bank portfolio does not necessarily translate into higher bank market capitalization. The fact that defaults are rare and the somewhat abstract nature of how capital underlies the ability of a bank to make a loan make it difficult for some bank managers to understand why concentration risk in a portfolio is such a bad thing. Since bank failures are very uncommon, a manager may see healthy income from a large, concentrated portfolio for years before a cluster of defaults throws the bank into difficulty. The bank's share price should, however, reflect this risk. Without proper incentives, a bank manager may conclude that he should capture as much income as possible now and worry later if the bank portfolio deteriorates. Our perspective, reflected throughout this book, is that share price, not portfolio size or portfolio income, should be integrated into a bank's performance management and compensation framework as a natural mechanism by which credit risk can be managed. Since the share price reflects the market's assessment of the firm's equity value, including the risk of insolvency, focusing on share price will align incentives of the bank's senior management and its line staff with the objectives of the shareholders.

Finance theory suggests that ACPM and the models used to separate the credit portfolio from a bank's (or other financial institution's) other businesses will lead the bank toward a higher share price. It is our view that operating in an environment where managers make decisions that lead to a higher market capitalization will, on balance, be best for the bank, its employees, and the country or countries in which it is located. It will also lead institutions away from a short-sighted search for profit at the expense of longer-term risk, given the objectives of management and the appetite of the shareholder base. Active credit portfolio management makes these trade-offs explicit and transparent.

OBJECTIVE OF THIS BOOK

As any new field of analysis develops, pockets of inefficiency and mischaracterization persist. Quantitative analysis is both revered and reviled. Some practitioners extol the virtues of returning to qualitative analysis of credit. Others dismiss existing models as oversimplifications of the world and insist that credit risk management demands more complex solutions—or much simpler ones. We tend to view the correct balance as sitting somewhere in the middle. A large swath of credit analysts still focus on fundamental analysis only. The number of vendors of credit analytics has increased, each pitching its own version of a credit risk management platform. Despite the increase in analytic firepower, the field is new enough to make standardization of approaches and techniques difficult in practice. The trends in the market married with the availability of analytics and tools

make understanding the concepts underlying these models an essential part of financial education today.

Our objective in writing this book is to provide a coherent and comprehensive (to the extent possible) framework for understanding and implementing effective credit risk management and credit portfolio management systems, evaluating credit trades, and constructing credit portfolios. It is worth repeating that this book is not intended to be an exhaustive survey of the broad literature on credit models or of all frameworks that have been developed or used. The References section at the end of the book provides sources to satisfy the reader's curiosity about other models and frameworks.

In our discussions, we tend to focus a bit more on a structural approach to analyzing credit risk, supplemented by other methods we think are useful in particular applications where the structural framework falls short. As it turns out, there are many applications where we will recommend the reduced-form modeling approach or a data-driven econometric one. A well-trained analyst will be comfortable with a variety of models and frameworks. While our preferred framework is grounded in economic explanations of default, our discussions of other frameworks are generally motivated by the challenge of making use of existing data. While we often find structural models most appealing from an intuitive perspective, in a number of settings such models cannot be practically implemented and thus pragmatism, rather then dogma, guides us. When helpful in highlighting our recommended approach, we discuss some other popular implementations of the models for certain applications.

In order to increase the reader's understanding of the models ultimately in use, we have tried to provide an (extremely) abbreviated history of how the models have evolved over time. We hope that this contextualization of how models have changed will improve the reader's grasp of the underlying concepts. We have not necessarily been comprehensive in these descriptions (again we refer the reader to the texts cited in the References to expand on our exposition); but we have highlighted the key developments that lead us to where we are today in terms of how models are used in practice.

MODELS IN PRACTICE

In all of these discussions, we warn the reader that we have developed strong views over the years and that we tend not to hide our opinions. We have acquired almost 20 years' experience in the credit arena and have developed deep-seated views about what a financial institution should and should not do to build value in a credit-related business. We plan to share this perspective. By way of disclosure, we note that in practice, an effective, *practical* framework will be rough around the edges with the odd inconsistency here

and there (usually to deal with available data or the lack thereof). Sometimes two seemingly incompatible models can have value in specific contexts, resulting in retention of both models despite the fact that they may not be consistent with each other from a theoretical perspective. In fact, we recommend that financial institutions look to multiple models and incorporate stress testing and reality checks frequently when building credit risk systems as a method for mitigating model risk.

Importantly, though, all models are not created equal and some models are better avoided. How can we make a determination as to the quality and usefulness of a particular model? Over time, we have developed the view that five criteria for evaluating a model or framework in the context of actual implementation of a credit risk and portfolio management system are useful:

1. Possibility of objective evaluation.
2. Interpretability of model output.
3. Relevance of model output to real and important business decisions.
4. Contribution to financial institution's value.
5. Reasonable cost relative to benefit of using the model.

Notice that criterion 1 immediately leads us down the applied modeling path. Many elegant mathematical credit models cannot currently (and in some cases may never) be tested, for lack of the right data. Other models reflect esoteric issues irrelevant to the real world of lending and trading.

Implicit in these five criteria is the view that objective evaluation will be facilitated by quantitative analyses and that those analyses will validate the performance of the model. Many times, however, we encounter quants who stop at criterion 1: quantitative validation. Their institutions will suffer for this narrow focus. The list is vitally important and speaks to the manner in which a model or framework changes and orients an organization.

In the end, a model will only be as good as the way in which it is used. The nature of the model—its fit along the dimensions previously outlined—can materially impact the probability of it being used well. One consequence of our perspective is that sometimes less elegant models from a theoretical (usually mathematical) perspective will be judged superior to models that reflect a theoretical infrastructure appealing to academicians. A good model will become integrated into the way a financial institution is managed on a day-to-day basis.

These five criteria lead us to the following conclusions:

1. Whenever possible, use models based on observable data and, if possible, choose market data.