Credit Risk Modeling

A Tool for Finding Competitive Advantage

Ravi Madapati

Given credit and market upheavals that can threaten a bank's survival, a defensive posture involving the rudimentary measurement of risk is understandable. However, taking a proactive approach that goes beyond the usual elements of loss avoidance and risk measurement is also vital to the continued well being and prosperity of a bank. While it may not be possible for a bank to maintain a full portfolio of well performing loans, still they can be expected to lend in a more prudential manner. CRM models help banks project risk, measure profitability and reduce the NPA levels. How does CRM lead to better allocation of capital by banks and financial institutions? Read on.

For centuries, financial intermediaries such as lenders, institutional investors, dealers, and insurers have engaged in risk modeling. In olden times the model was based on judgment and experience. Essentially, it involved categorizing and evaluating the proposed risk and reaching a series of interrelated decisions. For example, in the context of bank lending, for each potential credit those decisions included: (1) whether or not to lend, (2) at what price to lend, (3) what maturity should the loan have, and (4) what collateral to accept and how to structure it.

In recent times, sophisticated models have been developed to manage credit risk. Most Indian banks however continue to follow archaic risk management practices. Many have collapsed due to increasing **Non-Performing Assets** (NPAs). While it is not practical to expect a bank to have a full portfolio of well performing loans it can be expected of them to lend in a more prudential manner. Banks, above all other institutions, including corporations, insurance companies and asset managers, face the greatest challenge in managing their credit risk. Credit Risk Management (CRM) modeling can be very useful in this regard.

Given credit and market upheavals that can threaten a bank's survivability, a defensive posture involving the rudimentary measurement of risk is understandable. However, taking a proactive approach that goes beyond usual elements of loss avoidance and risk measurement is also vital to the continued well being and prosperity of a bank. CRM models help banks project risk, measure profitability and reduce the NPA levels. They take a firm wide view of the institution's risks, profits and opportunities so as to ensure optimal operations of the various business units.

Understanding Credit Risk

Credit risk is the risk of loss on a financial or non-financial contract due to the counter party's failure to perform on that contract. Credit risk has two components, default risk and recovery risk.

Credit risk is similar in some ways to **interest rate risk** or equity risk, usually referred together as market risks. Credit risk can be traded just as interest rate risk may be traded. A corporate bond or emerging market bond is an excellent mechanism for taking credit exposure to a particular issuer. The price of the bond is affected by changes in the credit risk or perceived credit risk of the issuer. A bond is not a perfect instrument for trading credit risk: Its price is also affected by changes in the general level of interest rates. On the other hand, credit risk has many properties that make it different from market risk especially for modelling purposes. A US Treasury bond is the quintessential example of a security that has interest rate risk, but no credit risk.

A second difference between market risk and credit risk is that changes in credit risk often cause the price of the associated debt instrument to "jump". And that jump can be very large, particularly when it is caused by default. In default, the recovery value can be a small fraction of the face value of the debt instrument.

Furthermore, the recovery value is highly uncertain and may only be determined after a prolonged negotiation process.

Credit Risk Modeling

Measuring the credit risk of a portfolio is a fairly involved process. Lack of liquidity makes it impossible to price credit risk for a specific obligor. Banks traditionally measure credit exposures by obligor and industry. They have only recently attempted to define risk quantitatively in a portfolio context. In particular, measured risk levels depend heavily on underlying assumptions such as default correlations, amount outstanding at the time of default, recovery rates upon default etc. Managers often do not have great confidence in these parameters. Other problems in estimating credit risk are that true default probabilities cannot be observed and default correlations are difficult to measure.

The elements of credit risk that require the most attention can be grouped as follows:

Individual Risk Elements

* **Default Probability:** The probability that the obligor or counter-party will default on its contractual obligations to repay its debt.

* **Recovery Rates:** The extent to which the face value of an obligation can be recovered once the obligor has defaulted.

* **Credit Migration:** Short of a default, the extent to which the credit quality of the obligor or counterparty improves or deteriorates.

Portfolio Risk Elements

* **Default and Credit Quality Correlations:** The degree to which the default or credit quality of one obligor is related to the default or credit quality of another.

* **Risk Contribution and Credit Concentration:** The extent to which an individual instrument or the presence of an obligor in the portfolio contributes to the totality of risk in the overall portfolio.

Methods and models for evaluating and pricing credit risk have been around for as long as individuals and institutions have extended credit. Banks, insurance companies, and credit rating institutions employ thousands of experts for evaluating individual institutions. For example, a credit officer of a bank analyzes fundamental data about a firm, industry, or country such as financial statements and economic data to determine the creditworthiness of the client. The findings of their efforts translate almost directly into the price of a loan or bond, or a decision on whether or not to buy a bond or make a loan.

CRM models start with the creditworthiness of the firm, industry, or country or some other known measures of credit risk. They, then describe the possible ways of the creditworthiness that may evolve over time. These models optimize the risk and return characteristics of the firm by better allocation of scarce credit risk capital to various businesses.

Four Questions to Gain Better Understanding of the Timing of a Credit Risk Episode

* Given the capital underlying the portfolio, are we generating the right return for our investors?
* Which assets provide the most diversification benefit to my portfolio?
* Which assets degrade my portfolio's performance?
* How do I improve portfolio performance? Which assets should I sell and in what quantity? Which assets should I buy, at what price, and in what quantity?


Optimizing for any given target means minimizing risk. A CRM model works by comparing the risk and return characteristics between individual assets or businesses. For example, if a new loan proposal comes to a bank for evaluation it is compared to the existing portfolio and the risk and return of the new loan proposal are evaluated in accordance with the existing portfolio. Say the existing portfolio of banks has cement, plastic, steel and IT companies in it. If the new proposal comes from a automobile company, the CRM model shows how much risk this company will add and also will indicate at what interest rate the automobile company should be given a loan.

This, it does by calculating the correlations between all the existing companies in the portfolio and the new company. Like the old adage says that, all the eggs should not be put in the same basket, the portfolio needs to be optimally diversified. The essence of diversification is to limit concentration of risk to say, one particular industry or one geographical location. Figure 1 depicts the various outputs of a CRM model.

The output of the model is the probability distribution of losses due to credit risk. A complete report will also describe where and how these losses might occur so that the credit risk manager can take appropriate action.

The marginal statistics explain the effect of adding or subtracting one asset to the portfolio. They help the bank to asses the attractiveness of the new asset and arrive at the right price. The last output, optimal

---

Figure 1: The Various Outputs of a CRM Model

Portfolio → Portfolio Credit Risk Management Model → Credit Risk | Marginal Statistics | Optimal Portfolio

---
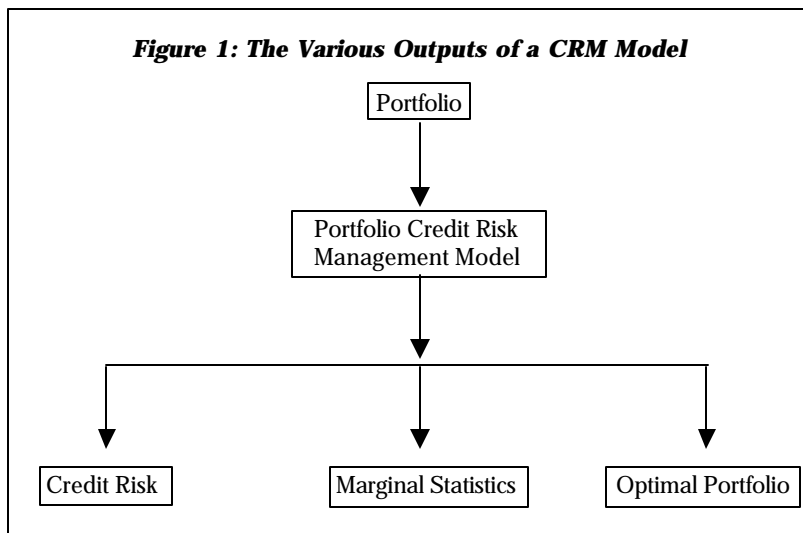
A Few Popular CRM Products in the Market

- **Portfolio Manager by KMV Corporation[1] :** The fundamental measure of credit risk provided by KMV is the EDF credit measure, which is the probability that the firm will default within a given time period. Such credit measures for traded firms are given in their Credit Monitor and for untraded (private) firms they are calculated in the Private Firm Model. This product uses Merton/Options based approach to calculating default probabilities.

- **Credit Metrics by J P Morgan Chase:** This product uses Monte Carlo simulations to measure portfolio loss distribution at the horizon date. Each obligor is assigned a credit rating and a transition matrix is used to determine the probabilities that the obligor's credit rating will be upgraded or downgraded, or that it will default. This software calculates the portfolio value by randomly simulating the credit quality of each obligor. The credit instruments are then repriced under each simulated outcome. The portfolio value is the aggregation of these prices.

- **Credit risk + by CSFB:** Unlike the Merton-based approach used by the other two products, this products methodology is based on mathematical models used in the insurance industry. Default risk is a series of continues random variables instead of an absolute level. Default correlations are generally caused by external factors such as regional economic strength or industry weaknesses etc. This product requires lesser amount of data than the other two.

[1]Moody's Corporation, a Credit Rating Agency, has recently acquired KMV.

---

portfolio, goes beyond the previos two outputs, in that it tells the credit risk manager the optimal mix of investments or business ventures. The calculation of such an output will build on the data and calculation of the previos outputs.

A very important component in the CRM model is the risk calculation engine, which calculates the expected returns, and distributions that are then used to calculate the associated risks and the optimal portfolio. Since the distributions are not normal, this portion of the portfolio model requires some ingenuity.

Taxonomy of Credit Risk Models
The three general classes of credit risk models are summarized briefly below:

- **"Value of the Firm" models:** These models view the firm's liabilities as contingent claims (i.e., options) issued against the firms underlying assets. As the **book value** of the firm's liabilities approaches the value of its assets, its default risk increases until the market value of the assets is no longer sufficient to repay the liabilities. Default, in this class of models, is therefore determined by the evolution of the firm's assets over time in relation to the various debt covenants or liability structure of the firm. If these "options" on the firm's assets are taken as the underlying framework for the default process, the probability of default can easily be calculated after some more simplifying assumptions.

- **"Recovery of Promised Payoffs" models**: These models view default as something that occurs when the firm's asset value breaches some exogenously specified absorbing boundary. This class of models posits that only a fraction of the risky debt—known as the "recovery rate"—can be recovered in the event of default. Depending on the underlying covenants, the risky debt has some promised future terminal pay-off. This class of models simplifies the default process of the "value o f the firm" models by making the cash flows to the promised payoff to the maturity of the debt. The trigger point for default is still dependent on the value of the firm's assets. So these models too do not use publicly available credit ratings information.

- **"Instantaneous Risk of Default" models :** The third class of models combines the two previous approaches. It considers a fractional pay-off of the promised debt in the event of default. But the time of default is exogenously modeled by assuming that when the "identical" but unlevered firm's asset value hits some exogenous boundary default can occur at any time in the levered firm paying off a fraction of the promised pay-off. The default process here is assumed to be independent of the capital structure of the firm (See 'A Few Popular CRM Products in the Market').

CRM in India
The Reserve Bank of India (RBI) has developed guidance notes on the management of credit risk and marker risk in Indian banks. The notes are very detailed and are emphatic about how serious RBI is on implementing CRM in Indian banks. Most banks do not have robust CRM tools in place and this has exacerbated the problem of NPAs. The need for CRM tools in Indians banks in clear and present. The Non Performing Assets (NPA) of 27 public sector banks shot up to Rs. 56,608 cr in September 2001. NPA not only reduces the yield on

Table 1: Non Performing Assets of PSBs in India as
(In Rs. crore)

Year	Gross NPA	Gross NPA as % of Gross advance	Net NPA	Net NPA as % of net advances
1993	39,253	23.2	NA	NA
1994	41,041	24.8	NA	NA
1995	38,385	19.5	17,567	10.7
1996	41,661	18.0	18,297	8.9
1997	47,300	15.7	22,340	8.1
1998	50,815	14.4	23,761	7.3
1999	58,722	14.7	28,020	7.6
2000	53,066	13.0	26,596	7.0
2001	56,608	13.0	27,856	7.0

Principles for Managing Credit Risk

The Basel Committee has prescribed a few principles for the management of credit risk. We examine the principles briefly:

A. Establishing an Appropriate Credit Risk Environment

- Principle 1: The Board of Directors should have responsibility for approving and periodically reviewing the credit risk strategy and significant credit risk policies of the bank. The strategy should reflect the bank's tolerance for risk and the level of profitability the bank expects to achieve for incurring various credit risks.

- Principle 2: Senior management should have responsibility for implementing the credit risk strategy approved by the board of directors and for developing policies and procedures for identifying, measuring, monitoring and controlling credit risk. Such policies and procedures should address credit risk in all of the bank's activities and at both the individual credit and portfolio levels.

- Principle 3: Banks should identify and manage credit risk inherent in all products and activities. Banks should ensure that the risks of products and activities new to them are subject to adequate risk management procedures and controls before being introduced or undertaken, and approved in advance by the board of directors or its appropriate committee.

B. Operating under a Sound Credit Granting Process

- Principle 4: Banks must operate within sound, well-defined credit-granting criteria. These criteria should include a clear indication of the bank's target market and a thorough understanding of the borrower or counterparty, as well as the purpose and structure of the credit, and its source of repayment.

- Principle 5: Banks should establish overall credit limits at the level of individual borrowers and counterparties, and groups of connected counterparties that aggregate in a comparable and meaningful manner different types of exposures, both in the banking and trading book and on and off the balance sheet.

- Principle 6: Banks should have a clearly established process in place for approving new credits as well as the amendment, renewal and re-financing of existing credits.

C. Maintaining an Appropriate Credit Administration, Measurement and Monitoring Process

- Principle 7: Banks should have in place a system for the ongoing administration of their various credit risk-bearing portfolios.

- Principle 8: Banks must have in place a system for monitoring the condition of individual credits, including determining the adequacy of provisions and reserves.

- Principle 9: Banks are encouraged to develop and utilize an internal risk rating system in managing credit risk. The rating system should be consistent with the nature, size and complexity of a bank's activities.

- Principle 10: Banks must have information systems and analytical techniques that enable management to measure the credit risk inherent in all on- and off-balance sheet activities. The management information system should provide adequate information on the composition of the credit portfolio, including identification of any concentrations of risk.

- Principle 11: Banks must have in place a system for monitoring the overall composition and quality of the credit portfolio.

- Principle 12: Banks should take into consideration potential future changes in economic conditions when assessing individual credits and their credit portfolios, and should assess their credit risk exposures under stressful conditions.

D. Ensuring Adequate Controls over Credit Risk

- Principle 13: Banks must establish a system of independent, ongoing assessment of the bank's credit risk management processes and the results of such reviews should be communicated directly to the board of directors and senior management.

- Principle 14: Banks must ensure that the credit-granting function is being properly managed and that credit exposures are within levels consistent with prudential standards and internal limits. Banks should establish and enforce internal controls and other practices to ensure that exceptions to policies, procedures and limits are reported in a timely manner to the appropriate level of management for action.

- Principle 15: Banks must have a system in place for early remedial action on deteriorating credits, managing problem credits and similar workout situations.

E. The Role of Supervisors

- Principle 16: Supervisors should require that banks have an effective system in place to identify, measure, monitor and control credit risk as part of an overall approach to risk management. Supervisors should conduct an independent evaluation of a bank's strategies, policies, procedures and practices related to the granting of credit and the ongoing management of the portfolio. Supervisors should consider setting prudential limits to restrict bank exposures to single borrowers or groups of connected counterparties.

Source: Basel Committee on Banking Supervision, Basel, September 2000.

advances but also reduces the profitability of banks. The huge NPAs of the banks is due to the debtor friendly foreclosure and bankrupt laws, which allows customers to default and this is also due to the lack of proper CRM practice. The gross and net NPA levels are given in Table 1.

RBI states the following regarding credit risk models. Credit Risk Models have assumed importance because they provide the decision maker with insight or knowledge that would not otherwise be readily available or that could be marshalled at prohibitive cost. In a marketplace where margins are

fast disappearing and the pressure to lower pricing is unrelenting, models give their users a competitive edge. The credit risk models are intended to aid banks in quantifying, aggregating and managing risk across geographical and product lines. The outputs of these models

also play increasingly important roles in banks' risk management and performance measurement processes, customer profitability analysis, risk-based pricing, active portfolio management and capital structure decisions.

To reduce the high net NPA levels of about 7% to more manageable 2-3% levels, credit risk tools should be implemented. Currently, none of the above mentioned tools or methodologies are being used in Indian banks. This can be attributed to two reasons. One is lack of awareness and the other is lack of credit risk professionals in the country. Both these problems can be overcome if we realize the importance on credit risk and how to manage it. This will help the banks in reducing the NPA levels and making optimal capital allocation choices.

Conclusion

CRM models are often criticized for their failure to predict. But this is an unfair criticism. One cannot expect these models to predict credit events such as credit rating changes or even defaults. True CRM models do not predict neither individual credit events nor collective credit events. But then there is no model that can predict an increase in the general level of defaults.

Formal models for credit risk are designed to augment judgment and experience and to help make better decisions. The difference between models and humans is that models rely on evaluating outputs, but the modeling process was inconceivable before the development of both modern finance theory and modern information technology.

Practitioners must never lose sight of the fact that CRM models need continued care and feeding to keep them in line with the latest knowledge. Parameters need to be set with due regard for low-probability events that may not be adequately addressed in recent data. The success of the CRM models depends on sound design, intelligent implementation and responsible application of the model. Most models that exist now are custom designed to solve the problems of an institution. A better understanding of these models will continue to advance cutting edge research in this field. It should be understood that a model could only help reduce the problem; it is the human judgment that should take the call.

The author is a Faculty at ICFAI Knowledge Center, an affiliate of ICFAI.

Keywords

Book Value:	The value of an asset or liability as it appears on a balance sheet. Book value often differs substantially from market price, especially in knowledge industries such as high-tech.
Interest Rate Risk:	It is the risk arising from the possibility that the yield expected from an investment may change due to changes in interest rates.
Non-Performing Assets:	These are the loans given by a bank or a financial institution, where the borrower defaults or delays payment of interest and principal amount for more than two quarters.

Primary Dealers Shifting Focus to Securitized Papers

Primary Dealers (PD), who have been dealing only in government securities and to a small extent in short-dated instruments such as commercial papers, have begun picking up securitized papers in a bid to push up their yield on assets. A number of PDs have already picked up some short-dated securitized papers of auto loan receivables placed in the market by some of the US banks through the private placement route. All the placements that have been picked up are papers floated through the non-recourse route. It implies that the buyer of the securitized paper would be assuming all the credit risks associated with the investment.

This has been the first time that PDs are lifting securitized papers through the private placement route. This sudden attraction for securitized papers is due to their attractive rates of return. With discounting rates of auto receivables in the 14% range, PDs hope to raise their profits through trading in these securitized papers. The PDs who had lifted these securitized papers would be offering a two-way quote to ensure the liquidity. This two-way quote would be made on a yield to maturity basis after factoring in a risk premium.

One of the major reasons for PDs to focus on these papers is the possibility of profits in the event of any further drop in the interest rates. The securitized papers that have been picked up by the PDs also face a very low default risk. Consequently, even if a default occurs in some segments, the cash flows to the subscribers would be unaffected. This structuring allows the yields on these papers to be considerably higher than what is currently earned on government securities.

The papers are also being made liquid by getting them listed in the debt-trading segment of National Stock Exchange, as there would be no change in the return profile if these papers were illiquid in nature. This is because the papers floated are essentially short-term in nature, with tenures less than three years. Moreover investments in such portfolios happen to be a small component of these portfolios, whereas the bulk of it would continue to be dominated by government securities and treasury bills.

Compiled by ICFAI PRESS Research Team from Business Line, *October 14, 2002.*