Collateralised debt obligations and bank capital

Joseph M. Pimbley analyses the relationship between collateralised debt obligations and bank capital.

The term collateralised debt obligation (CDO) describes asset-backed securities (ABS) in which bonds, loans, or a mixture of the two serve as the underlying collateral. Practitioners often use the CDO acronym interchangeably with CBO (collateralised bond obligation) and CLO (collateralised loan obligation). Regardless, the CDO instrument is more than 10 years old.

A critical element of the viability of the CDO as an asset class is the investor's analysis of the risk of each CDO tranche. The rating agencies perform the most visible analysis on behalf of investors. The ratings that the agencies assign opine on the level of credit risk of the particular CDO tranche. Though few market participants understand the various CDO rating analyses well enough to reproduce them, the market does appear to accept the ratings.

The rating analyses are essentially models of future potential loss to the investor. CDO and other ABS ratings were the very first significant quantitative modelling exercises at the agencies. Individual investors certainly have their own CDO risk models but, to the author's knowledge, they do not differ tremendously from those of the agencies.

All models consider the CDO to be a portfolio of debt obligations that will experience various levels of defaults that are correlated to some degree. Different agencies and investors will focus on different measures of loss: probability of default (any loss); expected loss; and variance of loss. These models have assumptions, many assumptions, concerning default probability, default correlation, recovery upon default, timing of defaults, et cetera.

Given the profusion of assumptions, nobody considers the models to be the 'ultimate truth'. Rather, they are intelligent guides for assessing risk. Astute investors combine their models and the agency ratings with their own professional judgement to reach investment decisions.

CDO investors are familiar with the discussion to this point. This article discusses the intriguing parallel between CDO rating models and the issue of capital adequacy for international banks. We will argue that the task of determining the risk to the senior tranche of a CDO is analogous to computing the risk to bank depositors. National and international regulators who wish to determine whether a bank is adequately capitalised must understand CDO risk assessment methodologies.

There does exist a standard procedure with which regulators assess bank capital adequacy. This procedure is evolving due to shortcomings and anachronisms. What appears to be best practice in regulatory capital assessment – and which will take years to implement – is a model determination that resembles CDO risk analysis. Explicit recognition of this similarity should help both practitioners and regulators in model testing, validation, and understanding.

This article discusses CDO risk analysis for background purposes. We then describe the 'bank capital problem' and its current status. The next step is exposition of the modelling for the 'right way' to do bank capital. We argue that specifying default correlation is the weak link in the current state-of-the-art and show loss distribution results for a credit risky portfolio that convey the critical importance of correlation assumptions.

Background: CDO risk analysis

CDO risk analysis begins by recognising that the CDO is a portfolio of debt obligations. Each individual obligation, a corporate bond or commercial loan, for example, has its own risk assessment in the form of a debt rating. The analyst generates a probability function to describe the likelihood of multiple defaults within this portfolio. Key elements in the analysis are the individual default probabilities – which come from the individual debt ratings – and the degree of correlation among the defaults.

The structurer of the CDO invariably partitions the portfolio into different tranches that are essentially different risk participations. One tranche, identified as 'equity' or 'junior' or 'subordinated' suffers all the default losses until such defaults deplete the tranche. All other tranches are senior to this equity tranche and begin to suffer losses only after the equity tranche is gone. Often there are only two tranches: equity and 'senior'. In other structures there are three in ascending order of seniority: equity; 'mezzanine'; and senior.

The investor or rating agency analyst focuses on one tranche at a time. He/she applies the priority-of-loss rule to the probability distribution of portfolio defaults. For example, in studying the senior tranche, the probability of a portfolio loss that is less than the total size of all subordinated tranches becomes a zero loss probability for the senior tranche since the subordinated tranches will bear all the loss.

The model that computes the probabilistic portfolio loss distribution likely varies from analyst to analyst. If one assumes that debt instruments default independently from one another, an analysis with a binomial distribution would suffice. Though some analysts do indeed presume zero correlation, the presumption is ill conceived. To incorporate correlation into the model, one must adopt a Monte Carlo simulation approach or make some other, generally arbitrary, adjustment to the number of debt obligations (Moody's) or to the individual default probabilities (Standard & Poor's and Fitch/IBCA).

There is also no standardisation of the measurement of risk in these analyses. Standard & Poor's and Fitch/IBCA appear to define the probability of any loss as the appropriate measurement. In contrast, Moody's assesses the expected loss of each tranche. Given the great disparity in definitions of loss, it is surprising that these agencies often assign what appear to be similar ratings. A cynical observer could accuse the agencies of uncommunicated collusion.*

It is odd that no rating agency has emphasised what seems to be the correct measure of risk: variability of loss. Risk is uncertainty and vice-versa. Portfolio managers understand this point well. In senior tranches it appears that 'expected loss' is a reasonable proxy for 'variance of loss'. But this relative indistinguishability may not hold in the more subordinated tranches in which expected loss is large.

Bank capital problem

Next, let us consider what at first seems to be a wholly unrelated issue: the specification of adequate capital for a bank. The Bank for International Settlements (BIS) issued a 'capital accord' in 1988 to specify adequate capitalisation levels for international banks. The goal of the BIS is to ensure that all banks are financially sound. The nature of banking, of course, is that individual depositors place their funds with banks and generally have the right to withdraw such funds at any time. The banks lend the funds to borrowers without the same right to call. Thus, as a core element of their business, banks take the risk that an unexpected crush of deposit redemptions will force them to default on their obligations.

Governments are loath to see such banking defaults since depositors themselves – who are taxpayers and, more importantly, voters – will suffer under such defaults. (Or, if the government has insured the deposits, the government will take the losses.) The event most likely to cause a run on the bank in which many depositors seek to withdraw funds simultaneously is news of the possible failure of the bank. Thus, government action in the form of regulation aims to prevent bank defaults by requiring sufficient capital.

That brings us back to the question of how to specify adequate capital for a bank. The 1988 BIS Accord correctly reasoned that the primary risk of bank default arises with the bank's portfolio of credit risk (mainly loans). The Accord specified that a bank's capital must equal at least 8% of the book value of risky loans and other credit exposure. To account for differences in risk between different loans, the Accord defined four broad categories. The BIS considered credit exposure to OECD governments to be risk-free. Thus, such exposure would have zero risk weighting which means that the book value exposure to such sovereign entities would be multiplied by zero. For determination of adequate capital, then, sovereign exposure would have no impact.

The second category designated a 20% risk weighting for OECD banks. For example, a US$10m loan to an OECD bank would be counted as a US$2m loan for the purposes of computing the capital adequacy of the lending bank. A third 50% category included the debt of certain sub-sovereign government entities. The last 100% category comprised everything else. As a very quick (and incomplete) summary, all credit risk would be 100% risk weighted with the exception of OECD sovereign and OECD bank credit exposure.

These risk-weighting rules form the core of the capital adequacy regime. Certainly market risk and operational risk are two other factors that regulators and rating agencies consider in assessing bank credit quality. Further, the 8% required capital consists of common stock, preferred stock, and subordinated debt. The BIS prescribes permissible amounts for each of these constituents.

The advantages of the capital accord are that the rules are easy to understand and implement and that they are "in the right direction". As the size of the bank's credit exposure increases, so should the capital. Broadly speaking, the accord accomplishes this goal.

But the accord's shortcomings are immediately evident. The set of rules does not measure appropriately the varied risks in a bank's portfolio. For example, loans to a Triple A corporate and a Single B corporate carry the same risk weighting as if the credit risks were identical. The risks are not identical, of course, and hence one cannot expect the capital accord to guarantee sensible results. Further, this Triple A corporate loan carries a higher risk weighting than does an obligation to Mexico or Turkey (OECD governments).

Finally, there is no requirement or concern regarding correlation within the bank's loan portfolio. The choice of 8% for the fraction of the portfolio that the bank should hold as capital appears to have arisen from an assumption of "average" correlation.

Improvement for bank capital

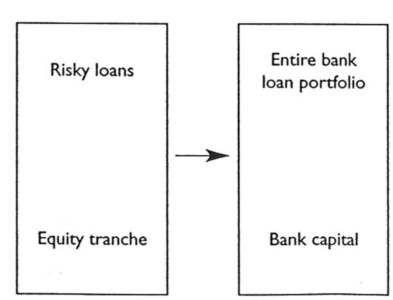
Bankers and regulators realise that the 1988 Capital Accord is flawed. The regulatory framework will improve. A current proposal will give limited benefits. Much of the industry anticipates that 'internal models' will supplant the risk weighting rules and its descendants. By internal model, we mean that each bank will develop mathematical calculations to determine its own safe capital level based on all relevant data of its credit risk portfolio. Auditors and regulators will test and verify these models.

This is the point at which the CDO rating models enter. The risk in the senior tranche of a CDO is essentially identical to the risk that depositors and senior creditors have in a bank. The parameter that regulators wish to determine, adequate bank capital, is analogous to the size of the equity tranche of a CDO. A common question in the investment world is whether the size of an equity tranche in an ABS deal provides sufficient safety to the senior tranche relative to the return.

This is precisely the question that regulators confront regarding the amount of bank capital and safety of the depositors. It is, therefore, perfectly reasonable to expect that a mathematical model for bank capital adequacy will be similar to existing, tested models for CDO risk analysis. Figure 1 portrays the analogy between CDO and bank capital structures.

Regulators have not yet decided that they will eventually move to an internal models concept for bank credit risk. If they do

Figure 1



make this decision, implementation remains years away. Yet most major banks have already built their own capital adequacy models. Even if not useful for regulatory purposes, such models are critical to investment choices. Most models are of the RAROC (risk-adjusted return on capital) type.

Not surprisingly given the correspondence, a typical RAROC model approximates the CDO model we described in an earlier section. The analyst must enter information on the bank's credit risky assets such as default probability, tenor, expected loss given default, and most formidably, the correlation of default of this asset with all other assets. Monte Carlo simulation most often serves as the numerical tool to generate the bank portfolio loss distribution from the default parameters. The analyst, auditor, and regulator must then inspect the loss distribution to determine adequate capital.

This loss distribution that plays such a prominent role in both the CDO risk and bank capital analyses deserves more discussion.

Figure 2 shows a loss distribution for a portfolio of 200 credit default swaps (which is a similar credit risk to 200 bonds or 200 loans of the same obligors). The horizontal axis measures a particular loss amount. The vertical axis measures the probability that the portfolio will sustain that particular loss. The portfolio size is $5bn and the mean default probability is 2% per annum.

The most difficult aspect of these portfolio loss models is the treatment of correlation among the risky assets. For the Figure 2 loss distribution, we classified each obligor within one of the 32 Moody's industry categories. We specified a high (40%) asset correlation for obligors within the same industry and a smaller (10%) asset correlation for those pairs in different industries. These asset correlations translate to smaller default correlations in a manner that depends on the default probabilities.

Figure 3 shows the 200-obligor portfolio loss distribution with absolutely no correlation. The difference is clear. The existence of correlation changes the shape of the loss distribution significantly. Perhaps paradoxically, it increases both the probability of very small loss and the probability of very large loss. Since the appropriate capital level depends most on the probability

Figure 2: Loss distribution for a portfolio of 200 correlated credit default swaps

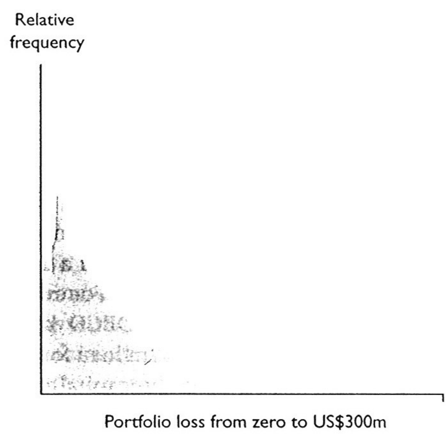
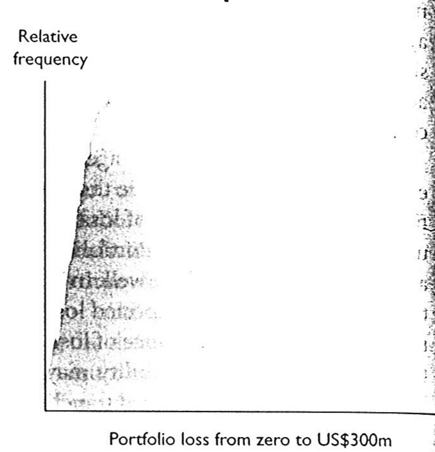


Figure 3: Loss distribution for a portfolio of 200 uncorrelated credit default swaps



of large loss, the specification of positive correlation among the obligors increases the capital level over that of the zero correlation assumption.

Zero correlation, which is not realistic, implies that any two obligors will default independently of one another. Analysts expect some degree of positive correlation among obligors since all corporations are dependent on the strength of the economy. When the economy weakens, most borrowers will become more likely to default.

We call correlation the most difficult aspect of portfolio loss models since there is essentially no completely reliable method for imposing default correlations. The method I employ here of assigning an inter-industry and an intra-industry correlation value based on Moody's classifications is really just a guess. The best practice in the industry is to use equity value correlations for asset correlations. This method appears to be an improvement, but nobody has determined how to test whether the resulting default correlations are accurate.

Summary

International banks are the backbone of the global financial system. The core business of these banks is extension of credit. As a direct consequence they must bear and manage portfolios of credit risk. Regulators determine and dictate the adequate capital that banks must hold against this credit risk.

The current capital adequacy method must and will improve. It is possible, though not at all certain, that regulators will permit banks to create and employ internal models to compute appropriate capitalisation. In this circumstance, regulators and other third parties would audit and test the models. There is, naturally, much concern that the models will not be sufficiently accurate.

The purpose of this article is to make the point that capital adequacy models must be similar in nature and results to risk analysis models for collateralised debt obligations (CDOs). The industry has more than ten years of experience with (rating agency) CDO risk models. Thus, regulators have this existing pool of data to analyse to assess whether CDO models are conservative and robust. Prior and existing CDO issues are bank histories that we may study to determine if the rating agency capital assessments (required subordination levels) were prudent and correct.

This article discussed the analogy between CDO analysis and bank capital determination. We described CDO risk analysis as well as the existing "risk weighting" rules of the 1988 Capital Accord. We also showed (Monte Carlo simulation) loss distribution results to demonstrate the importance of default correlation assumptions.

*Bear in mind, though, that while the market considers a *Moody's* Aa3 rating to be equivalent to the *S&P* AA- rating, the agencies themselves have never directly claimed that investors should assume this correspondence. But neither have they labored to discourage the comparison.