Credit Risk

Two fundamental approaches to credit risk management:

• The internally oriented approach centers on estimating both the expected cost and volatility of future credit losses based on the firm’s best assessment.
  – Future credit losses on a given loan are the product of the probability that the borrower will default and the portion of the amount leant which will be lost in the event of default. The portion which will be lost in the event of default is dependent not just on the borrower but on the type of loan (e.g. some bonds have greater rights of seniority than others in the event of default and will receive payment before the more junior bonds.)
  – To the extent that losses are predictable, expected losses should be factored into product prices and covered as a normal and recurring cost of doing business, i.e., they should be direct charges to the loan valuation. Volatility of loss rates around expected levels must be covered through risk-adjusted returns.
  – So total charge for credit losses on a single loan can be represented by 
  
  \[
  \frac{\text{expected probability of default}}{\text{expected percentage loss in event of default}} + \text{risk adjustment} \times \text{the volatility of} \left( \frac{\text{probability of default} \times \text{percentage loss in the event of default}}{\text{expected levels}} \right)
  \]
  – Portfolio effects require estimation of correlation between the volatilities of loss rates around expected levels of individual loans (expected losses are just additive).
  – Credit risk capital is assigned based on the volatility of portfolio losses.

• The market-oriented approach centers on the cost assigned to credit risk by the marketplace. This would typically be the spread above the risk-free (i.e., government) rate on bonds or loans.
  – Knowledge of the credit spread does not distinguish between the portion being charged for expected losses and the portion being charged for risk-adjustment of volatility of losses nor between the contribution of probability of default vs. the contribution of portion lost in the event of default.
  – The market oriented approach focuses on the possible changes in this credit spread over fairly short time periods (days or weeks).
  – Portfolio effects accounted for the same as with market risk VAR — by looking at observable correlations between quoted spreads.
  - Credit risk capital is assigned by the same methodology used for market risk capital.

• The internally oriented approach has tended to dominate at commercial banks and for loans, the market-oriented approach has tended to dominate at investment banks and for publicly traded bonds. The market oriented approach has many of the same advantages as the parallel approach for market risk — the ability for “outsiders” to monitor the success of investment strategies without the same access to information as “insiders.” Correspondingly, the internally oriented approach is subject to manipulation by “insiders.” But the market oriented approach is dependent on publicly available prices at which positions can (reasonably) readily be put on and unwound. Historically, these conditions tended to be far more true for bonds than loans. But several trends are moving in the direction of favoring the market oriented approach for loans as well:
- Increased loan syndication and loan trading, accompanied by easier access to price quotations at which loans can be purchased and sold.

- The growing use of credit derivatives which allow the purchase and sale of loan risk even when the loans themselves are not traded

**Details of internally oriented approach**

There are two fundamental variants. One is based on statistical analysis of historical experience of occurrence of default and loss in the event of default. The second is based on representing a firm's debt holders as having sold a put on the value of the firm and using option theory to analyze the probabilities of default and loss in event of default. We will first describe how each of these two variants analyzes a single firm's debt and then describe how each of the two variants extends this analysis to a portfolio.

**Analysis of a Single Firm's Debt — Statistical Approach**

A brief discussion is given in the section "Using Historical Data" in Hull 23.1, a more extended discussion in section 2.2 of Crouhy-Galai-Mark. Two separate sets of statistics are used for judging probability of default and judging loss in event of default. Probability of default is based on tables like 23.2 from Hull or table 1 and 2 from Crouhy-Galai-Mark. These tables are based solely on the credit rating of the borrower, not the type of debt, since cross-default legal provisions come close to guaranteeing that a borrower will default on either all of its debt or on none of it. S&P and Moody's also publish such transaction matrices based on finer gradations of credit rating. Loss in event of default is based on tables like 23.2 from Hull (also shown as table 6 in Crouhy-Galai-Mark), which distinguishes between different seniority levels of lender.

Large lending firms may have their own internal data on defaults and loss in event of default which they may wish to use to supplement the publicly available data which comes from Moody's and S&P. However, even if this data has been well-maintained, there is a trade-off between using data which may be more relevant to the particular class of borrowers who are customers of a particular firm and the loss of accuracy which comes with utilization of a smaller sample (particularly when utilizing transition matrices with finer gradations, some cells of the matrix may be based on very small samples.) One criticism of use of the Moody's and S&P matrices is that they are based largely on experience with US based firms and may be less applicable to non-US firms. But data on the default experience of non-US firms is not easy to obtain.

Even if a firm chooses to base all its statistical data on publicly available information, it still may choose to base its categorization of borrowers on something other than the Moody's or S&P ratings. For example, a bank may choose a categorization determined by its own loan officers, both because this allows the bank to take advantage of its internal experience with particular borrowers and because of a belief that the rating agencies change ratings with too long a lag from when there have been changes in a firm's credit risk. In order to be able to utilize transaction matrices from publicly available data, the internal categorization must be calibrated to corresponding public categorizations. Some of the other possible sources of ratings categorization are:

- Statistical models fitted to balance sheet and income statement data.

- Econometric models fitted to macroeconomic variables describing financial conditions in different countries and industries (see section 5 of Crouhy-Galai-Mark).
Option-based models can be used not to directly project default rates but to categorize borrowers and then rely on statistical data on transition probabilities. This approach, typified by the firm KMV, will be further discussed when we take up the option-based approach.

Since transition matrices between credit ratings allow probability of default to be calculated and since standard deviations of loss upon default rates are available as well as expected values (in fact, full probability distributions are available), it is possible to calculate probability distributions of default loss providing both expected values and measures of uncertainty. Moody's and S&P also make available data on the variability of transition matrices over different years, which can also be used in calculating probability distributions of default.

**Option-theoretic approach**

A firm's equity is viewed as a call option on the value of the firm's assets with a strike price equal to the face value of the firm's debt. This is equivalent to viewing the equity owners of a firm as having a put option to pay off the debt holders with either the face value of the debt or the total value of the firm's assets, whichever is smaller. So the total economic value of the firm's debt to the debt holders must be the face value of the debt less the value of this put option.

The advantage of the option-theoretic approach is that it can derive default probability and recovery rates from variables which can be observed in the marketplace (remember that by contrast, the market-oriented approach cannot distinguish the impacts of these factors from one another or from the charge for the risk of volatility of losses). By utilizing market information, it is hoped to reduce the time lag in recognizing changes in default probabilities which is inherent in the statistical approach, which requires time for credit analysts to react to new information. In addition, the option-theoretic approach is the only one which can link together credit valuation and equity valuation into a single coherent theory.

Let us first look at a very simple version of the options model, which can be found in Hull, 23.1, “Using Equity Prices: Merton’s Model”. This model has four key simplifying assumptions: (1) the firm has only a single class of debt outstanding and this is zero-coupon debt, and the firm will not issue any new debt before this debt matures, (2) if the firm defaults, this will only occur at the time of the maturity of this debt, (3) the firm's behavior, such as the riskiness of its investments, will not be impacted by how close it is to default, (4) no intermediate payments to equity holders, such as dividends. At the price of these simplifying assumptions, the model only requires four inputs — the time to maturity of the debt, the market value of the firm’s assets, the present value of the firm’s debts, and the volatility of the firm’s assets — and can give explicit formulas, in terms of these three inputs, for the probability the firm will default, the recovery rate of debt holders in the event of default, the required interest rate spread over the risk-free rate for the firm's debt, and the market value of the firm's equity and of the firm's debt.

Using notation close to that in Hull, we'll denote

- $V_0$: current market value of firm's assets
- $D_0$: present value of the firm's debt which matures at time $T$, discounted at the risk-free interest rate
- $\sigma_V$: volatility of the firm's assets

Viewing the equity as a call option on the firm's value with a strike price of the face amount of the debt, we can write a formula for the current market value of the firm's equity as:
\[ E_0 = V_0 N(d_1) - D_0 N(d_2) \]

Where \( d_1 = (\ln(V_0/D_0) + \sigma_v^2 T/2) / \sigma_v \sqrt{T} \)

\[ d_2 = d_1 - \sigma_v \sqrt{T} \]

The current market value of the firm’s debt is just \( V_0 - E_0 \).

Following the standard Black-Scholes analysis, \( N(d_2) \) represents the probability that the strike price will be exceeded at time \( T \). But this is the probability that the firm will not default, so the default probability

\[ P_D = 1 - N(d_2). \]

If we let \( R \) stand for the recovery rate of debt holders in the event of default, if there is no default the debt holders receive the face value of the debt and if this is a default, the debt holders receive the recovery rate times the total assets, so we can write the market value of the debt as

\[ (1 - P_D) D_0 + P_D RV_0 \]

So, \( V_0 - E_0 = (1-P_D) D_0 + P_D RV_0 \)

Substituting from (1), \( V_0(1-N(d_1)) + D_0 N(d_2) = N(d_2)D_0 + (1-N(d_2))RV_0 \)

\[ R = (1-N(d_1)) / (1 - N(d_2)) \]

If the debt were truly risk free its market value would be \( D_0 \). The credit spread on a zero coupon instrument can be written as \( s \), where the market value (MV) of the instrument is the face amount \( F \), discounted by \( r + s \), where \( r \) is the risk free rate.

\[ MV = Fe^{-Tr} \]

\[ e^{-Ts} = MV/Fe^{-Tr} \]

\[ s = -\ln (MV/Fe^{-Tr}) / T \]

We know the market value of the debt is \( V_0 - E_0 \) and the present value of the debt described by the risk free rate, \( Fe^{-Tr} \), is \( D_0 \).

So, \( s = -\ln ((V_0 - E_0)/D_0) / T \)

\[ = \ln (D_0 / (V_0 - E_0)) / T \]

Two of the four required inputs, \( T \) and \( D_0 \), are straightforward to determine, providing all of the firm’s debts are reported in some publicly filed statement. To use the model as an approximation when there are several maturity dates for debt and the debt has scheduled coupon payments, \( T \) can be calculated as the weighted average duration of the debt.

In theory, you could obtain \( V_0 \) by summing the market prices of all of the firm’s equity and debt and estimate \( \sigma_v \) by looking at historical volatility of this sum. In practice, most firms have some amount of debt which is not publicly traded and for which a market price would therefore not be available. (There is also some circularity in using observed market prices of the debt as one of
the inputs to a formula to determine the "correct" market price of debt, though this could possibly be justified by assuming the market has a correct valuation of the total value of equity and debt without necessarily having the right split between the two).

The inputs which can be obtained easily are the market price of equity, \( E_0 \), and the volatility of equity price, \( \sigma_E \), which can be based on both historical observation and implied volatility from equity options. To obtain \( V_0 \) and \( \sigma_V \) from \( E_0 \) and \( \sigma_E \) you solve the simultaneous equations:

\[
E_0 = V_0 \, N(d_1) - D_0 \, N(d_2)
\]

And \( \sigma_E \, E_0 = N(d_1) \, \sigma_V \, V_0 \)

The latter equation can be derived from Ito's lemma and the implication, from the first equation, that \( N(d_1) \) is the partial derivative of \( E_0 \) with respect to \( V_0 \).

To do away with the simplifying assumptions of the model considered thus far, we could move to a Monte Carlo model which reproduces many possible future paths of the firm's asset value. The growth rate of the asset value assumed would be the risk-free rate by the usual risk-neutral valuation argument. It is easy in the context of a Monte Carlo model to build in payments due to different maturities of debt with coupons, build in rules for when default will occur (such as when the net worth of the firm is below a certain threshold), build in rules for the distribution of asset value in the event of default to different seniority level of debt, build in behavioral rules for the firm's response to different levels of net worth (such as increasing asset volatility as the net worth gets close to the default threshold), and build in rules for dividend policy. By summing over all paths in the Monte Carlo model, it is easy to compute expected default rates by time period, recovery rates in the event of default by time period and by seniority level, and the market value of equity and of each combination of maturity and seniority level of debt. Required spreads over the risk-free rate for each combination of maturity and seniority level of debt can be computed from the market value. When the assumptions of the simple options model are input to the Monte Carlo model, the same result are obtained as from the simple model.

When this model is implemented, a problem immediately appears. If the default threshold is set greater than zero and if asset values are assumed to follow paths without jump processes, then the required spread over the risk-free rate can be driven as close to zero as you like by increasing the frequency with which observations of the asset value are taken. Increasing the frequency of observation increases the probability of default but also causes the loss in event of default to approach zero by dividing up the assets of the firm among the creditors while they are still sufficient to pay off the creditors in full. This shows that the key issues in determining default loss are behavioral rather than financial, that is, they depend critically on how transparent the operations of the firm are to creditors and how much control the creditors can exercise in forcing bankruptcy in a timely fashion. This may differ significantly by government jurisdiction, as will the role governments may play in providing help for firms close to default. So the usefulness of options models for determining default probabilities and values is questionable.

Options models can still play a useful heuristic role in helping to understand the default process. This is the role they play in the models of the KMV Corporation, the leading consulting firm in using options models to study default behavior. The KMV methodology is summarized in section 3 of the Crouhy-Galai-Mark paper and is discussed in more detail in the paper "Using Equity Price Information to Measure Default Risk" written by Peter Crosbie of KMV.
The KMV approach is to utilize a model somewhat like the simple option model we have discussed but to use it not to try to directly measure default probability but rather to produce a measure called "distance to default" which is then used to project default probabilities based on an empirically-fitted statistical model. The insight behind this is that, while the behavioral nature of default requires the use of statistical observation of past experience, the options model output can be a valuable input to this process when used comparatively to judge which firms are relatively more likely to default than others.

KMV presents the following points in favor of this use of the option model:

- Because the model is based on equity market prices, which are continuously observable, it is more likely to represent the latest available information than the ratings of just a single firm's credit officers or of a rating agency or on statistical models based on accounting information which is only available periodically.

- The model takes into account both the capital structure of a firm and its business and industry risk. Capital structure is represented by the leverage, the ratio of total firm value to equity. Business and industry risk is represented by the volatility of asset values (e.g., you can expect much more volatility from a firm in a high technology industry than a utility, much more volatility from a firm in an emerging market country than one in an established industrial country.)

Distance to default is measured by the number of standard deviation movements it would take to put a firm at the point which default is a serious possibility. In the terms of the simple model we presented, it would be \((V_0 - D_0) / (V_0 \sigma_V \sqrt{T})\). The actual model used by KMV in calculating distance to default is more complex than our simple model in several ways. To highlight a few:

- Our simple model assumes default can only occur when firm asset value is insufficient to make a required payment. The KMV model recognizes that firms can be forced to default when their asset values decline sufficiently below the present value of required future payments. Based on empirical studies, KMV has set the default point, which in our model is \(D_0\), as the sum of short-term debt, representing required current payments, and one-half of long-term debt, representing payments which will be required in the future. In this way, assets can decline below required future payments by some amount, but not too far, before default is threatened.

- The KMV model can handle more liability classes than just straight debt and equity; it can also accommodate hybrid classes — convertible debt and preferred stock.

- KMV regards the equation \(E_0 \sigma_E = N(d_1) V_0 \sigma_V\) as too simplistic, since it does not take into account the impact of varying leverage levels through time on the relationship between equity volatility and asset volatility. KMV uses a more complex model, details of which they do not specify, to reflect this factor.

**Analysis of a Portfolio of Debts**
To analyze a portfolio of debts, we need to combine the information on default probabilities and loss in event of default for single firms with information about the correlation of default events between firms. In principle, statistics on default correlations could be based on direct historical observation. But in practice, defaults are sufficiently unusual events to make such statistics questionable. Two principal approaches to estimating these correlations have been proposed.

1. The option approach to viewing credit risk can be used to convert observed correlations between equity price moves into correlations between changes in the asset value of firms and correlation between asset values can then be converted into default correlations. This is the approach followed by both Credit Metrics and KMV. The Credit Metrics approach is outlined in some detail in section 2.3, 2.4, and 2.7 of the Crouhy-Galai-Mark paper.

To reduce the dimensionality of estimating equity price move correlations between thousands of borrowers, Credit Metrics uses a multi-factor regression analysis relating changes in equity returns of a given firm to changes in country and industry indices. Since these indices are common independent variables for the equity returns of many firms, this allows equity, and hence asset, return correlations to be derived. Crouhy-Galai-Mark also discuss the similar KMV approach in section 3.5.

To convert from asset correlations to default correlations, Credit Metrics then relies on empirical mappings from probability of default, derived using KMV’s distance to default concept, to credit ratings migrations.

2. Credit Portfolio View utilizes econometric modeling of the default rate based on independent variables which measure the macroeconomic state of the economy for different countries and industries. Again the use of common independent variables allows correlations between firms to be derived, but in this approach default rates and credit migration are taken directly as the dependent variable, rather than working through the intermediate stages of equity and asset returns. See section 5 of Crouhy-Galai-Mark.

**Details of market oriented approach**

Hull, 23.1, shows how to derive the expected loss from default for zero-coupon bonds from par yield curves for corporate bonds and Treasury bonds, using the same bootstrapping technique used to derive discount curves from Treasury par curves. The bootstrapping technique is applied to observed corporate bond prices to derive zero-coupon corporate bond prices. Comparison of n-year zero coupon corporate bond prices and n-year zero coupon Treasury bond prices gives a credit risk discount factor which can be applied to any n-year cash flow with similar seniority from that issuer. Given a complete set of such discount factors, the MTM valuation of any credit instrument can be calculated as the sum of each of its cash flows multiplied by the respective credit risk discount factor and time value discount factor. Note that the credit risk discount curve could be different for instruments of different seniority of the same firm. Note also that the credit risk discount factors derived are composite factors which account for probability of default, loss in event of default, and risk premium for uncertainty of payment without permitting any decomposition of the impact of each factor.
**Counterparty Credit Risk**

Counterparty credit risk requires input from both disciplines of market risk and credit risk. Loss will occur only in the event of counterparty default, and so requires credit risk assessment, but the size of potential loss is not fixed, as with bonds and loans, but is determined by how much a derivative contract is worth at the time of default. Estimation of potential moves in derivatives contract values is traditionally a concern of market risk.

The standard approach to handling this interaction between market and credit risk is to separate the two contributions into independent factors which can be worked on separately. In this model, the market risk area considers market risk factors alone in assessing the size of potential moves in derivatives contract value. Based on a set probability threshold (e.g., 99th percentile), the “near-maximum” amount which can be lost in the event of counterparty default is calculated. This near-maximum amount of loss in event of default is then treated as the equivalent of the principal of a loan, which is also the maximum amount which can be lost in the event of default (assuming no recovery), and credit risk personnel is expected to evaluate the reasonableness of taking on the risk of this loss just as if they were evaluating making a loan of that size.

This approach depends critically on independence assumptions (discussed in Hull, section 23.2):

- The probability that the counterparty will default cannot depend on the value of the market variables underlying the derivative, so the derivative contract and instruments priced off the same market variables cannot be a significant enough portion of the counterparty’s business to induce a correlation between the size of move and likelihood of loss.
- The timing of default must be independent of the size of market moves.

The assessment of near-maximum exposure in the event of default, the market risk part (discussed in section 23.2 of Hull) starts with the current MTM of the derivative and then projects how this MTM might grow through time based on a certain selected number of standard deviations of movement in market variables.

- Figure 23.3 in Hull illustrates the two major patterns with which MTM will grow through time. Currency swap continue to grow in exposure with the square root of time, based on increasing uncertainty as to the underlying variable. Interest rate swaps initially grow in exposure and then decline, based on the offsetting forces of increase with square root of time based on increased uncertainty of the underlying variable, and decrease in exposure, roughly linear with remaining time to maturity, based on decrease in duration.

- Potential exposure reflects the cost of replacing a derivative with another counterparty. Liquidity costs for less heavily traded derivatives should be reflected through assumed bid-asked spreads or through lengthening the time over which near-worst case market moves are measured to reflect not just time to default but the added time till replacement can be found after default.

- The use of measures to mitigate counterparty credit risk, such as requiring cash settlement or posting of collateral after MTM exposure grows to a certain point should be reflected by measuring potential exposure as the maximum MTM permitted before settlement plus the near-worst case market move which can take place over the time period it is estimated that it will take to enforce settlement.
• Netting the exposure between different derivatives with the same counterparty should only be permitted in circumstances where netting is legally enforceable (this varies by country, based on differing bankruptcy laws). When netting is permitted, it can definitely be done between exposures to the same variable, since high US 3M LIBOR rates and low US 3M LIBOR cannot coexist at the same time. It is more difficult to set rules for netting between exposures to different variables, such as US 3M LIBOR and UK 3M LIBOR, since possible correlations must now be brought into account. In principle, a calculation similar to VAR could be performed on all the legally nettable exposures of a single counterparty to determine the near-worst exposure for a selected probability.

• The measure of exposure produced is only useful as input to credit decisions such as whether a credit extension to a particular counterparty leaves the firm more exposed to that counterparty than is prudent. For such decisions, the maximum that could be lost in the event of default is a reasonable measure of risk. For decisions which should depend more on portfolio considerations, such as measures of the total credit risk of the firm across all counterparties, or measures of whether the firm is receiving an adequate return on the credit risk it is taking to a particular counterparty, this measure of exposure is inadequate. A measure of exposure would need to look not just at the near-worst case loss but on the expected amount of loss and standard deviation of loss in the event of default. This can be computed by similar means but full probability distributions of loss need to be computed.

• There are cases where the required independence assumption breaks down
  - In some equity derivatives and credit derivatives there are close ties between the counterparty’s credit and the variable determining the MTM of the derivative. The most extreme example is a company writing a put on its own stock — it will owe the most in the circumstances it is most likely to default. A less extreme case would be a Brazilian bank writing a default swap on another Brazilian bank. Their economic conditions are likely to be closely correlated, giving rise to a probability that large exposure will correlate with counterparty default.
  - Sometimes exposure of a counterparty to a country’s economic circumstances will be strong enough to call into doubt the independence assumption for even interest rate and FX derivatives. An example which recently caused major losses was Russian banks’ FX forwards to deliver dollars against rubles. When the ruble collapsed against the dollar, the Russian banks lacked the economic strength to deliver the promised dollars. This has led to concerns about the validity of the independence assumption on “wrong way” derivatives, where a firm will owe money when its home currency is weak.
  - When the independence assumption is violated, it is necessary to have a cross-disciplinary effort between market risk and credit risk to develop an integrated model of default risk taking into account the correlation between probability of default and size of exposure in event of default.

• There has started to be interest in stress testing counterparty credit risk, analogous to the stress testing performed for market risk. At a minimum this would involve applying market risk stress tests to the current MTM portion of the credit exposure, as well as to any market value of any collateral being held against the position. But it could also involve using higher volatilities in calculating the evolution of MTM and in looking at
correlation of higher exposure levels and downgrading of counterparty credit ratings which might be associated with particular stress scenarios. This is one possible method for dealing with the issue of “wrong way” derivatives exposure.

- Calculating the potential counterparty exposure for settlement risk is generally much simpler, only requiring an analysis of the operational aspects of the settlement. So if the settlement details of an FX contract call for delivery of the dollars 12 hours prior to receipt of the Yen, the party delivering dollars will have a 12 hour counterparty exposure for the full amount of the Yen which is owed.

**Reducing exposure to credit risk**

Look at Hull, section 23.2, for a discussion of methods for reducing credit risk, including:

- Setting limits on total exposure to a given counterparty
- Limits can also be set on credit risk concentration, by sectors such as industry and country
- Requiring the posting of collateral, particularly in conjunction with counterparty credit risk
- Collateral agreements need to be factored in the calculations of potential counterparty exposure. For example, a five-year FX forward would normally have potential counterparty exposure calculated using the volatility of the FX rate over a five-year period. But if there is a firm requirement for the counterparty to post collateral against its exposure and if the procedures for monitoring that collateral assure that if adequate collateral is not posted the transaction will be terminated and settled within 30 days, then the volatility of FX rates over a 30 day period should be used in the calculation of potential counterparty exposures.
- Downgrade triggers which increase the spread paid in the event of a ratings downgrade
- The purchase of credit derivatives to offset undesired credit exposure to a firm. Loan sales and loan syndications can also be used to accomplish this goal. The purchase of credit derivatives against counterparty credit risk on derivatives involves correlation risk. The amount of credit derivatives needed increases and decreases with the value of the derivatives whose counterparty exposure is being hedged. If the credit spread is likely to widen at the same time that the counterparty exposure increases, there will be added expected costs due to this correlation.
- Dealing with subsidiaries of a firm which are designed to be protected from events which might trigger the bankruptcy of the parent firm

**Credit Derivatives**

Varieties of credit derivatives

- Total return swaps — one party receives a fixed coupon and receives the full return on a bond or loan over a set period of time (e.g., a 3-year swap on a 5-year bond pays a fixed coupon for 3 years and at the end of 3 years makes a payment based on the value of the now 2-year bond’s market value; payment from the party receiving the fixed coupon will be required if the bond is trading below par. Cash flows on a TRS can be replicated by buying the underlying bond or loan and financing it with term funding. So the MTM of a TRS should just be the MTM of the bond or loan minus the MTM of the term funding. Bonds and loans can be MTM using market prices, and term funding can be MTM using
the standard discounting of risk-free payments techniques. So no new methodology is needed to value TRS.

- Default swaps — one party receives a fixed coupon for a set time period. If the underlying instrument does not default during that time period, no other payments are made. If the underlying instrument does default during that time period, the party receiving the fixed coupons must pay the difference between par and the after-default value of the underlying instrument (the mechanism for achieving this takes many different forms and is the subject of much controversy — one possibility is for the other party to deliver the underlying instrument and receive par in payment). An N-year default swap on a T-year floating rate instrument is equivalent to the difference between par and an N-year floating-rate instrument of equivalent seniority and issuer. The argument is that if there is no default during the N-years, then an N-year floating-rate instrument will end at par, which is equivalent to no payment on the default swap. And if there is a default during the N years, there should be no difference in the discount to par of an N-year floating rate instrument or a T-year floating rate instrument of the same seniority and issuer. So MTM a default swap on a floating rate instrument requires no new methodology beyond MTM techniques for bonds and loans. Default swaps on fixed rate assets can be broken down into a default swap on a floating rate asset and a standard fixed-for-floating interest rate swap with the issuer as counterparty, so MTM can be broken down to these two pieces.

- Basket default swaps — swaps which pay a fixed coupon but which require payments based on the default behavior of a basket of instruments. Payment is not just a straight sum of what payments would be owed on the sum of individual default swaps. Some basket default swaps only require payment on the first default which occurs in the basket. Others require payments only up to a fixed amount, beyond that amount further defaults do not require payment. MTM for these instruments cannot be directly derived from existing bond and loan prices, but require default models which include estimation of default correlation. These models should be calibrated to available bond and loan prices, but there will remain room for differences in models which calibrate to the same data.

Note that Collateralized Loan Obligations and Collateralized Bond Obligations are a bond plus basket default swap in which the total amount which can be lost is limited by the initial amount invested in the bonds (plus possible buildup of reserves.)

Use of basket default swaps to hedge existing credit risks leaves traditional lenders with residual credit risks which also have the characteristic of no longer having MTM derivable from existing bond and loan prices, but requiring default models which include estimation of default correlations.