Correlation – the hidden risk in Collateralized Debt Obligations

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Collateralized Debt Obligations are one of the most interesting innovations of the securitization market in the 90's. They create new, customized asset classes by allowing various investors to share the risk and return of an underlying pool of debt obligations. The attractiveness to investors is determined exactly by the underlying debt and the rules for sharing the risk and return.

A Collateralized Debt Obligation is a correlation product. Investors in this product are buying correlation risk. To determine that they are getting a fair return for this risk, they must be able to measure the correlation risk.

Since the 1950's when Markowitz did his pioneering work on portfolio theory[2], there has been intense study of correlation between equity investments. Equities are liquid and have relatively small transactions cost – lending themselves well to portfolio re-balancing.

Correlation between debt securities has not been studied so intensely – possibly because debt securities other than US Treasuries are not liquid and have high transactions cost.

Up to now Collateralized Debt Obligations (CDO), of which Collateralized Bond Obligations (CBOs) and Collateralized Loan Obligations (CLOs) are two examples, have not been subjected to intense correlation analysis. This is due to the historical development of the market.

In a relatively short time the CDO market has seen two extremes. In the late 80's and early 90's these securities were mainly sold as credit arbitrage investments. The spread on non-investment grade credits were at historical highs. In particular, spreads were much higher that the historical loss rate on non-investment grade credits. This meant that the spread more than compensated the investor for the additional risk.

Thus CDO's created windfall profits for all investors, and, in particular, the investor who took the greatest credit risk, sometimes earning returns of 30% to 40% or higher.

More recently, credit spreads have completely reversed. In the last few years spreads on non-investment grade corporates and emerging markets are at historical lows – barely enough to justify the extra credit risk (as the market may just be finding out).

Nevertheless CDO's have been quite resilient and their stamina is due to the fact that they are capital arbitrage mechanisms. Banks use CDO's to free up regulatory capital by securitizing the higher layers of credit risk.

If CDO's are to survive swings in credit spreads and default rates as well as new regulation, then the market will have to understand their intrinsic benefit as portfolio management tools.

CDO's are backed by a pool of debt obligations. The debt may be bonds, loans, revolving credit facilities, structured finance obligations, and almost any other kind of debt obligation one may imagine.

The debt may be foreign or domestic or some combination. It may be investment grade or high yield or some combination.

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[2] Markowitz, Harry, "Portfolio Selection," *J. Fin.*, March 1952, pp. 77-91.

The market classifies CDO's into two broad categories: market value structures and cash flow structures. The two categories are not completely disjoint. There are examples of CDO's which have characteristics of both classes. In any case, all CDO's have an investment manager who manages the collateral. He must follow the rules set out in the offering circular.

The interest and principal payments are redirected to the various investors through what are called *tranches.* There are always at least two tranches. The tranches are ordered so that losses in interest or principal to the collateral are absorbed first by the lowest level tranche and then in order to the next tranche and so on. The mechanism for distributing the losses to the various tranches is called the *waterfall.*

Losses occur when there is some kind of *credit event.* A credit event is usually either a default of the collateral, or a credit downgrade of the collateral. In either case, the market value of the collateral drops. The lowest tranche is the riskiest and is called the *equity* tranche. All the tranches except the equity tranche have credit ratings. The highest tranche is usually rated triple-A.

Equally important is not only with the occurrence of credit events but also the timing and the *severity.* By severity, one means the exact loss, that is, the non-recoverable amount of the debt. It is well known that credit events are not independent.

Credit events are uncertain and the number is variable. Of course, the fewer the number of credit events the greater the benefits to *all* investors. In addition, the less variability in the number of credit events, the greater the benefits to *all* investors. This is another way of saying the better the diversification, the better the investment.

There is conservation of risk and return. The value of the CDO's is the value of the proceeds of the various tranches, which is the same as the value of the underlying pool of debt (plus or minus management fees). So if one miscalculates the risk of one tranche, and, therefore misprices that tranche, then one automatically misprices the other tranches.

To accurately measure risk and return one must quantify the diversification. An investor in a particular tranche (or investment-rating agency) wants to know the likelihood of sustaining a loss and the likely severity of that loss. In statistical language he wants to know the exact probability distribution of losses to the underlying pool of debt.

The probability distribution depends on both the probability of a credit event and relationship between two or more credit events. In statistical language this is called *non-independence* of events. Correlation is a measure of non-independence, but it is only one number and does not capture the complicated nature of credit events.

For example, it is well known that the correlation between interest rates and defaults is almost zero. However, a careful examination of historical data shows that defaults tend to occur in extreme interest rate environments – either low or high rates.

The science of credit analysis is quite sophisticated, but not until recently have people begun to think about credit ratings in term of probability of default. The correlation of defaults is been thought about even less.

Work done to date on default is based on historical data. Unlike other risk factors such as forward rates and volatility, correlation is not easily observable or tradable. Indeed, many derivative instruments exist for trading rates and volatility. No such instruments exist for correlation.

Various kinds of risks contribute to credit risk. Industry, country, or economic risk are *systemic risks* in that they simultaneously affect more than one entity. So two entities share an Industry, country, or economy may have non-independent credit risk. *Specific risk* is that risk which is specific to one entity.

There are many models of credit risk and correlation of credit risk. The first model of default was Black-Scholes (1974) and Merton (1974) who observed that a corporation defaults (roughly) when its assets fall below its debt obligations. This leaves one to model assets. The obvious first approximation was to assume assets follow lognormal Brownian Motion (as in the model for equity). This model naturally extends to model portfolio credit risk. Since the invention of the Black-Scholes and Merton model, there have been other models.[3]

One problem with most models is that they try to measure the non-independence by a single number, namely, correlation. As mentioned above non-independent is much more complicated than a single number.

A second problem with these models is that they assume correlation, or even non-independence, is constant over time. A casual review of historical data shows that industries which may have been related at one point in time may not be related later on.

To compensate for these inadequacies one sometimes uses conservative inputs to the model. The result is that the model then undervalue the senior tranches or, equivalently, under valuetheir credit quality.

Recentyl there have many strides in modeling and, in particular, econometric modeling. The most important inputs into the calculation of the probability distribution are outlying events – not average default rates or average correlations. An analysis of historical defaults shows that default rates are not constant over time. There have been periods where the number of defaults has spiked up.

Figure 1 illustrates how various models approximate the probability distribution of losses in the collateral of a CDO. Notice that all the models mostly agree on expected losses but greatly disagree on the variability of the losses.

The losses are concentrated in the left of the graph. These losses first affect the lowest tranche of the CDO. Of course all the tranches are concerned with the variability of the losses, but the lowest tranche is affected more by the way these losses are correlated with the rest of his portfolio. The highest tranches are affected when the losses are excessive and in the range of $150 MM or more.

The last of the four distributions was calculated by a model which incorporates both the non-stationarity of defaults and the non-independence of defaults.

Figure 2 gives a close look at how various models approximate the probability distribution of losses by looking at losses above $150 MM. In this region the shortcomings of the models are amplified. Slight changes in correlation assumptions have a profound affect on the calculation of expected losses to the higher tranches.

While this figure shows the all but one of the models underestimate the losses to the higher tranche, this is not typical. The point is that most models are inaccurate and will almost always miscalculate the risk.

Collateralized Debt Obligations are the exciting product which will continue to evolve and remain a staple in every investment manager's portfolio. But in order to gain greater acceptance and application, there must be a parallel development in our understanding of defaults and, in particular, correlation. This knowledge will not only benefit CDO's, but will find applications across all lines of risk management including all kinds of portfolio risk management and capital allocation.

[3] Skora, Richard, "Rational Modeling of Credit Risk and Credit Derivatives," *Credit Derivatives,* Risk Publications, 1998.

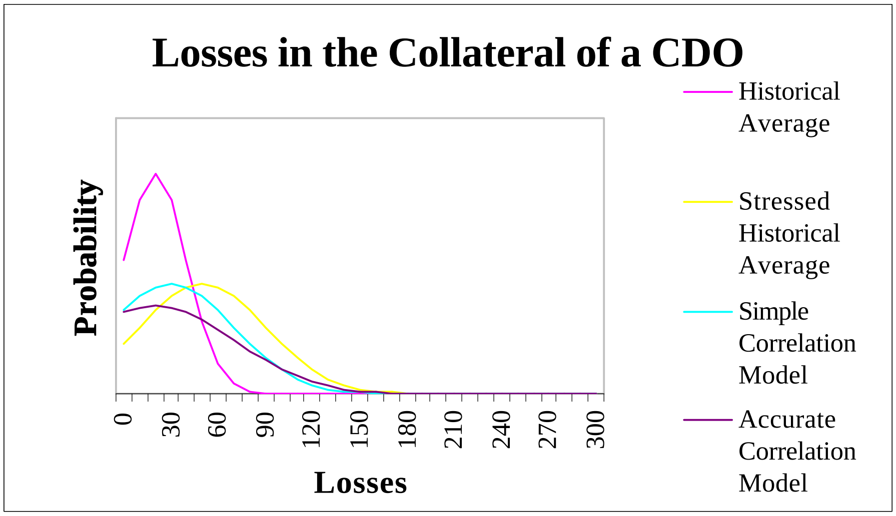

Figure 1
Losses in the Collateral of a CDO

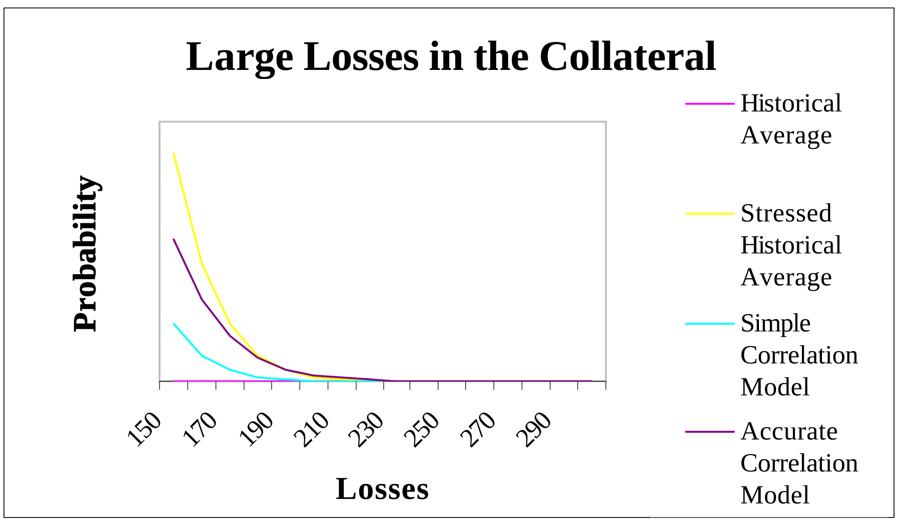

Figure 2
Large Losses in the Collateral of a CDO

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Skora & Company has already helped financial and non-financial institutions set up profitable credit derivatives trading desks, build cutting edge portfolio credit risk management systems, and design efficient credit risk/return performance analytics.

Richard K. Skora is the founder of Skora & Company. He worked in the credit risk management since 1992. He also traded various exotic credit derivatives including default swaps, default options, and basket swaps.

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