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Credit risk assessment of fixed income portfolios using explicit expressions

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ABSTRACT

We propose a model to assess the credit risk features of fixed income portfolios assuming they can be characterized by two parameters: their default probability and their default correlation. We rely on explicit expressions to assess their credit risk and demonstrate the benefits of our approach in a complex leveraged structure example. We show that using expected loss as a proxy for credit risk is misleading as it does not capture the dispersion effects introduced by correlation. The implications of these findings are relevant for improving current risk management practices and for regulation purposes.

1. Introduction

Fixed income portfolios are normally subject to credit risk, that is, there exists the possibility that some of their assets could default, which, in turn, could result in monetary losses. For example, a key aspect of portfolio management consists of monitoring the credit risk profile of its assets with the aim of triggering corrective actions whenever the risk exceeds some specific level. Additionally, regulators need to understand and quantify the credit risk exposure of the entities they supervise (for instance, banks, insurance companies, pension funds, swap counterparties, to name a few) to make assessments regarding their solvency. Finally, and more broadly, we speculate that the recent financial (subprime)

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crisis was caused by an inadequate understanding of the distribution of credit risk within the global financial system.

The naïve approach to deal with portfolios subject to credit risk is to ignore the correlation altogether and treat the defaults as independent random variables. This leads to the conventional binomial distribution. Unfortunately, most real-life situations involve portfolios that exhibit some degree of correlation and thus this approach is quite misleading. The recognition of the importance of correlation lead to Standard & Poor's (S&P), a rating agency, to deal with correlation—at least initially—by artificially increasing the value of the portfolio default probability p according to ad hoc rules (Standard & Poor's (1999)). In essence, S&P treated the pool of assets as being independent with the hope that the effect of correlation could be somehow accounted for by modeling the behavior of the pool using a higher (conservative?) value of p. In recent years S&P has abandoned this approach.

Another rating agency, Moody's, suggests a method that recognizes the importance of correlation and addresses it via the Diversity Score (DS) concept in combination with the binomial expansion technique (BET), proposed by Cifuentes and O'Connor (1996). The idea behind this method is simple as it relies on the assumption that one could mimic the default behavior of the original pool of assets by using an "ideal" pool made up of uncorrelated bonds that have the same aggregate notional amount of the actual portfolio. This method is the *de facto* and has been the preferred approach by many analysts for a number of years. Moreover, Moody's approach relies extensively on the BET method for structured products ratings (Schönbucher (2003), Fender and Kiff (2004)).

More recently, after Li (2000) introduced the Gaussian copula concept to the financial community as a way of generating correlated random vectors (based on a given correlation matrix), Monte Carlo simulations flourished. Notwithstanding the popularity and increasing level of sophistication of these Monte Carlo simulations methods, an unpleasant fact remains. That is, they rely on controlling the asset correlation, a variable related to, but different than, the default correlation, the variable with which we should be concerned. While a full discussion of this issue is beyond the scope of this paper, it has been treated in detail by Cifuentes and Katsaros (2007).

In the last few years, several authors, such as Hull and White (2006),Kalemanova et al. (2007), Longstaff and Rajan (2008) and O'Kane (2008), have proposed more elaborate models that incorporate the possibility that an asset may default at any time between 0 and some distant horizon T, yet still introduce correlation in some ad hoc manner. In this article, we introduce a far simpler model that relies only on two parameters: the assets default probability (p) and their default correlation (ρ). We do not rely on asset correlations as they are presumably estimated from returns, another variable that—even though easy to observe—does not obviously capture default correlations.

It may appear that our model is overly simplistic. However, despite this simplicity, it proves to be far more insightful and accurate than either the BET method or Monte Carlo simulation based on the Gaussian copula. In fact, as will be evidenced using a simple example, our model captures a salient feature of the portfolio loss distribution that, thus far, has gone unnoticed—two humps, one at each end of the distribution. Monte Carlo simulations based on the Gaussian copula—for all their complex correlation matrices and different default probabilities for each asset—cannot account for this salient feature, which is critical to assess the likelihood of experiencing extreme events. Moreover, our example will also show that relying on the expected loss as a proxy to assess credit risk is quite misleading, as this metric misses the dispersion behavior of the loss distribution, thus again giving an inaccurate appraisal of the portfolio credit risk.

2. Density of losses

The default behavior of a single asset (or bond, as these two terms will be used interchangeably in this presentation) is a binary event—default/ no default—that can be fully described with one parameter—its default probability p. The problem at hand is more interesting because we consider a portfolio of assets. Hence, we assume that we have n homogeneous bonds, all of which have the same notional amount and the same default probability p. However, this requires the incorporation of an additional piece of information, namely, the correlation. To be precise, the correlation we are referring to in this context is the correlation between the default behavior of any two assets within

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