

Introduction

If you put the federal government in charge of the Sahara Desert, in five years there'd be a shortage of sand.

Milton Friedman

The credit derivatives market surged from USD 200 billion in 1997 to an astonishing USD 55 trillion in 2008. The largest growth happened in 2006 and 2007. When associated with the *securitization* process, the CDS asset class was in the driving seat of the enormous economic and consumption expansion that took place in the world economy in the post-internet bubble years.

A proper and detailed introduction to credit derivatives can be found in many books already on the market. For an overview of the credit derivatives market, the available instruments, their valuation and trading strategies we refer to the JP Morgan *Credit Derivatives Handbook* (JP Morgan, 2006) and to the Morgan Stanley *Structured Credit Insights* books (Morgan Stanley, 2007a; 2007b). For an introduction to stochastic calculus for finance we refer to Shreve (2004a; 2004b), and to Bingham and Kiesel (2004). For an introduction to credit risk modeling we refer to Bluhm et al. (2003). We refer to Schönbucher (2003) and O'Kane (2008) for credit derivatives pricing. A classic work on options, futures and other derivatives is the book by Hull (2003). For an overview of the bond market we refer to Fabozzi (2004).

This book complements the above references in many respects. First, we focus on the standardized credit indices. Second, we try not to focus only on the instrument and the models but also on the market developments, attempting to adopt a very critical view when using a model. Third, we show models to price instruments, both standardized credit indices and bespoke tranches. Fourth, we show models for portfolio management purposes of bespoke credit portfolios. Fifth, we position the securitization business model as key to the world economy and we describe the processes underlying the activity that need to be well understood. Sixth, we propose a framework to be put in place in financial institutions in order to manage the activity.

When pricing a single name credit derivative instrument, known as a *credit default swap* (CDS), one needs to have a default model. There are two widespread approaches in the industry for doing this. The first is based on the equity market, and in the second a default process is postulated. The two approaches are briefly described in Chapter 2. Initially, the market was predominantly a single name protection instrument. However, in the last few years there has been a drive for multiname instruments for portfolio risk management purposes, rating of whole portfolios and for pricing of multiname CDSs, raising the necessity of models for default dependency within a portfolio. The classical solution has been to use the concept of copulas, and this is described in Chapter 3. In both cases we keep the description to the minimum required to understand the remaining chapters.

We then move forward to Part II of the book where we focus on the pricing of single name credit instruments. In Chapter 4 we show how to price a CDS, the simplest synthetic credit instrument, using the intensity model described in Chapter 2.

We develop two approaches to calibrate the model to observed market spreads. A first taste of the book can be seen when we go one step further and describe practical reasons why one model is chosen over another. Additionally, we show a table comparing the recovery rates on some defaulted bonds during the credit crunch.

In Chapter 5 we price a single name credit spread option using trinomial trees typically used for interest rate processes. Although the chapter is based on a published work (see Garcia et al., 2003), and on data from 2001, the study is still very relevant as the option market is still OTC and not yet fully developed. We show again a comparison between model and reality. In addition, we highlight the parallels in terms of modeling purposes between interest rate and the default intensities, and between discount factors and survival probabilities. The subject will become more relevant once the market comes to use the indices for active portfolio management purposes, a key proposal of this book, in which case one will certainly evolve in the direction of term structure of volatilities of the expected loss.

The collapse of Bear Stearns and the bankruptcy of Lehman Brothers served to highlight the importance of counterparty risk in CDS contracts. In a very short time, protection buyers of CDSs sold by Lehman Brothers realized that their contracts were not as safe as they thought. In order to understand the complex nature of those events, consider a retail bank that sold to its wealthy clients USD 200 million of a capital guaranteed instrument structured by Lehman Brothers (LB). Suppose, for example, that the instrument was a credit constant proportion portfolio insurance (CPPI) issued by LB. The sudden bankruptcy meant that the retail bank got all the exposure to a complex product it might not be able to manage being potentially exposed to any trading loss on the product. The issue of counterparty risk and the so-called credit valuation adjustment (CVA) is addressed in detail in Chapter 6.

Part III of the book is dedicated to corporate multiname credit derivatives. In Chapter 7 we describe what *collateralized debt obligations* (CDOs) are, giving a brief overview of the instrument. The chapter addresses very important issues that underlie the current credit crunch. That is, we show the differences between cash and synthetic deals, the cost of regulatory capital showing explicitly how the instrument is suitable for leveraged positions at the cost of systemic risk. Moreover, we point out the issues of concentration, correlation and diversification inherent to the instrument. The chapter is important in order to understand how CDOs can lead to liquidity problems and why the standardized credit indices are needed.

In Chapter 8 we give a description of the corporate standardized credit indices iTraxx and CDX, focusing on the importance of standardization. In that chapter we give a first intuitive way of pricing the index. The widely-used one factor Gaussian copula algorithm to price tranches of the standardized credit index is described in detail in Chapter 9. We also show how to adapt the model to use Lévy processes. The importance of using Lévy models cannot be emphasized enough. The need for it can be seen in the work of Mandelbrot who was among the first to have studied Lévy processes in finance. We first describe the algorithms used by practitioners. The discussion about self-organized criticality and Mandelbrot is postponed to the final part of the book. The chapter describes the problems of implied compound and base correlation, pointing out the interpolation problems, central to any pricing algorithm for tranches of CDOs.

A more in-depth study comparing Gaussian copula with Lévy base correlation is presented in Chapter 10. The concept of base correlation solves the problem of pricing bespoke tranches. The problem with the base correlation approach, however, is that it is not an intuitive concept, and neither is it straightforward to guarantee arbitrage free pricing. Those issues can only be guaranteed within the concept of base expected loss described in more detail in Chapter 11.

One of the most important applications of the standardized credit indices is the pricing and hedging of bespoke portfolios and for this one needs the concept of correlation mapping. In Chapter 12 we show different methodologies available in the market for choosing the appropriate correlation for pricing purposes of a bespoke tranche. It should be clear that pricing is currently more an *art* than a science and the user needs to understand the implications prior to choosing one particular algorithm over another.

In Chapter 13 we show how correlations among tranches are impacted by the assumptions on systemic risk for the underlying collateral. This chapter is very important for risk, regulatory capital and accounting purposes.

In Chapter 14 we describe cash flow CDOs, presenting a waterfall or indenture in detail. We describe one of the first methodologies to analyze CDOs, the Binomial Expansion Technique (BET), first developed by Moody's. Although it is current best practice to use Monte Carlo (MC) simulation, we decided to describe the old BET approach in some detail due to its central role in the risk analysis of CDOs that led to the failure of a certain large company during the credit crunch. The curious reader is advised to rush to that chapter.

Structured credit products such as Constant Proportion Portfolio Insurance (CPPI) and Constant Proportion Debt Obligation (CPDO) are described in Chapter 15. With the credit crunch and the enormous losses suffered by CPDO investors, this instrument became a symbol of a risky product in which models failed. We had foreseen this danger. It could have been detected by comparing the results of simulation driven by Brownian motion with simulations based on jump-driven Lévy processes. This is yet more evidence that pricing means first understanding the nature of the product and only then selecting an appropriate model to catch possible features and hidden risks.

In Part IV we address CDOs of Asset Backed Securities (ABS). The different protocols used in the market for ABCDSs, that is CDSs of ABSs, are described in Chapter 16. In Chapter 17 we present one credit event model to price CDOs of ABSs, showing the complex problems faced by the industry associated with the input parameters. Given the importance of the asset class, one needs standardized credit indices for pricing and hedging purposes. Some of those indices are described in Chapter 18 and we focus on ABX.HE and TABX.HE, the standardized credit indices for subprime Mortgage Backed Securities (MBSs). In Chapter 19 we show how to adapt the standard market approach for pricing tranches of corporate credit indices to price TABX.HE, the tranches of ABX.HE, both under the Gaussian copula and Lévy models. The deterioration in the subprime MBSs was visible in the TABX.HE tranches. Additionally, we show that, when using the prepayment assumptions taken from the remittance reports there was no value of correlation that would recover observed market prices. An important message of this chapter is that, in order to be able to foster the securitization business model at low cost of capital, key ingredients are the standardized credit indices and transparency in the methodologies for pricing purposes. This also implies the ability to map portions of the bespoke portfolio into the capital structure of standardized credit indices. If the pricing algorithm is one factor then one may use the techniques described in Chapter 12. This implies the assumption by the market of a risk neutral prepayment assumption for pricing purposes. One of the current difficulties in pricing CDOs of ABSs is the input spread parameter from which probabilities of default are implied. Differences in probabilities implied from an ABS bond and ABCDS are due to the cost of funding of the former, the mark to market nature of the latter, and liquidity issues. In Chapter 20 we adapt the techniques widely used for the corporate case to come up with the basis between ABCDSs and the ABS bonds.

In Part V we point out that a solution for the securitization business model for financial institutions requires understanding the relation between widespread investment in apparently safe AAA securitization instruments and its catastrophic impact on the stability of the whole financial system. To this end, we discuss long-term memory processes and self-organized criticality central to the work of Benoit Mandelbrot and others. An intuitive description of those processes is given in Chapter 21. We also mention the inappropriateness of the Gaussian framework for pricing and portfolio management purposes. We then move to Chapter 22 where we address in detail the credit crunch and its link with securitization. We show via an intuitive example that the process to be followed is the dynamic of systemic correlation that can be monitored via the standardized credit index. It turns out that the dynamics of correlation follow a long-term memory process. We know that the probability of extreme events is much higher than expected under the Gaussian framework. One solution to the stability problem is to significantly increase the cost of capital for securitization instruments.

This medicine kills the sickness – instability – but also the patient – the securitization activity – and with it a large part of the world economy as we know it. One cannot expect the world to stop thinking in Gaussian terms overnight as all the systems and the mathematical framework in the heads of the practitioners are based on Gaussian distributions. In Chapter 23 we present a solution for the whole puzzle. We show the inadequacy of a regulatory capital framework that is portfolio independent. Moreover, we show the inadequacy of the correlation values that have been used for securitization instruments for both risk management and rating purposes. Next we unveil the implicit assumptions of liquidity adopted by practitioners when rating agency models are used for structuring purposes. This leads us to the necessity of exchange traded standardized credit indices. Continuing along this path, we propose a mark to market approach for securitization instruments within a dynamic credit portfolio management framework as one possible solution for the securitization business model.

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