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Book Review of

Credit Risk: Pricing, Measurement, and Management

by Darrell Duffie and Kenneth J. Singleton

2003, Princeton University Press, 396 pages

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Abstract

Credit risk is the major challenge for risk managers and market regulators. Banks, regulators and central banks do not agree on how to measure credit risk and, more particularly, on how to compute the optimal capital that is necessary for protecting the different partners that share this risk. Asking banks to keep too much capital in reserve to cover credit risk can be a source of market distortion in risk management behavior. All these issues arise in part because credit risk is not well understood. So the contribution of Duffie and Singleton will be welcomed by the academics, regulators, and practitioners who consult it. The book has thirteen chapters, three appendices (two on affine processes), a comprehensive list of references, and an index (authors and subjects). It covers all subjects related to credit risk. The main focus is modeling credit risk: measuring portfolio credit risk and pricing different securities exposed to credit risk. The focus on credit risk management is less important. The book covers with great clarity the relevant topics of credit risk. It reflects the strong academic competence of the authors. This is certainly the best reference on credit risk available on the market. I recommend the book to academics and professionals, and also for the teaching of credit risk at Masters and PhD levels in finance and economics.

Keywords: Credit risk, pricing, measurement, management.

JEL classification: D80, G12, G13.

Credit risk is the major challenge for risk managers and market regulators. International regulation of banks' credit risk was put in place in 1988 and since that time there has been no consensus on how to improve that regulatory framework. Part of the explanation resides in the complexity of this risk. Banks, regulators and central banks do not agree on how to measure credit risk and, more particularly, on how to compute the optimal capital that is necessary for protecting the different partners that share this risk. For example, what proportion of yield spreads on corporate bonds is explained by credit risk? Is it 30%, 50% or even 90%? Is the credit risk proportion of the observed spreads solely a function of variations in the default probability or is it also explained by variations in the recovery rate over time or across cycles? Are

macroeconomic cycles themselves or default risk premia, market liquidity and even market risk significant determinants of yield spreads? These questions are important because some models such as CreditMetrics use the entire yield spread to compute the capital for credit risk. If credit risk explains only a small fraction of yield spreads, these models compute too much capital for regulation and even for credit risk management (Dionne et al. 2004, and references).

Asking banks to keep too much capital in reserve to cover credit risk can be a source of market distortion in risk management behavior (Allen and Gale, 2003; Dionne and Harchaoui, 2003). For example, it may generate some asset substitution activities that increase the risky position of banks, in order to set the level of risk at its optimal rather than regulatory level. All these issues arise in part because credit risk is not well understood. So the book by Duffie and Singleton will be welcomed by the academics, regulators, and practitioners who consult it.

The book has thirteen chapters, three appendices (two on affine processes), a comprehensive list of references, and an index (authors and subjects). It covers all subjects related to credit risk. It is designed for three broad audiences: academics and graduate students; those involved in the measurement and control of financial risks; and those involved in trading and marketing products with significant credit risk. The main focus is modeling credit risk: measuring portfolio credit risk and pricing different securities exposed to credit risk. The focus on credit risk management is less important in the book.

The introduction (indeed the entire book) is very well written and presents the subjects treated with clarity. Credit risk is distinguished from other sources of risk such as market risk, liquidity risk, operational risk, systemic risk, and regulatory and legal risk. The distinctions take many dimensions such as time horizon, liquidity, the parties implicated, methodology, and information asymmetries. However, the authors insist on the fact that this does not mean that all these different risks should be managed separately. These different risks may be correlated over time, so integrated frameworks for measuring and pricing them are necessary, particularly for market, credit and liquidity risks. For example, factors underlying changes in credit risk are often correlated with those underlying market risk and changes in liquidity risk can be viewed as a component of market risk and may generate credit risk. The last chapter proposes an original way of integrating credit and market risks in a portfolio model.

The introduction also provides an overview of the book. The chapters are organized to highlight the major topics related to credit risk, such as: Definition and Management (chapter 2), Default and Transition (chapters 3 and 4), Valuation (including valuation of credit derivatives, chapters 5 to 9), Default correlation and Portfolio valuation (chapters 10 and 11), Credit risk in OTC derivatives positions and Portfolio risk measurement (chapters 12 and 13).

The book also introduces many concepts that are not often discussed in the literature. Examples are: gapping risk into market prices (page 9), synthesizing (page 180), overshooting (page 320), and rogue traders (page 6).

Chapter 2 is about general principles of risk management, with an emphasis on proper definitions (e.g. "Risk management is the process of adjusting both the risk of large losses and the firm's vulnerability to them" page 14), significance (extreme losses), payoff asymmetries and

incentives, asymmetric information inside and outside the firm, allocation of capital and risk-adjusted return on capital. Risk measurement is also discussed in detail, with an emphasis on tail loss. The chapter ends with an interesting section on the measurement of credit risk. A more formal treatment of credit risk measurement is presented in Chapter 13.

Chapter 3 provides a detailed treatment of default risk which is presented as the central part of pricing and hedging credit risk. Basic structural and reduced-form models are reviewed in detail as well as two methods for default-time simulation. Statistical models of default likelihoods are also reviewed. The main objective is to compute the best approximation of default probabilities conditional on the information available from balance-sheet ratios, industry and country characteristics, and macroeconomic variables such as business cycles. The variation of such default probabilities in relation to new information is also analyzed. Ratings from agencies or internal models represent a good source of information but may not be sufficient for many banks or other financial institutions with particular asset portfolios. GNP variation is usually not sufficient to capture the information that would explain variations in default rates and spreads. Industry information seems to be more accurate but remains an aggregate measure.

This chapter presents the basic mathematics of forward default rates and their links with the term structure of default risk as well as other fundamental concepts (and their mathematics), such as distance to default, default intensity, hazard rate, jumps, CIR intensities (Cox, Ingersoll and Ross), affine intensity, concepts essential to understanding credit risk and the remainder of the book. In other words, the reader must understand the material of chapter 3 in order to appreciate the book and have access to the best treatment of credit risk in the market.

Capital reserves for credit risk approximated by market yield spreads can also be explained by anticipated changes in credit ratings and rating transitions. Chapter 4 reviews the basis of rating transitions and the alternative models appearing in the literature. One interesting part of the discussion is devoted to the cyclical aspects of transition matrices. As documented, there may be momentum in rating transition data and ignoring this aspect of transition matrices may produce basic matrices that report transition frequencies which have been computed with sample averages rather than conditioned by all available information. Using these frequencies to approximate default probabilities may introduce biased estimations of default probabilities and rating transitions (Lando and Skodeberg, 2002). One consequence of this may be under evaluation of default probabilities and under evaluation of the credit risk proportion in yield spreads (Dionne et al. 2004). Ratings may also contain an aging or duration effect, in the sense that a bond default or transition probability can be a function of the time spent in a credit rating.

In the second part of the chapter, the authors present the econometrics of credit rating analysis, starting with qualitative-response models such as the Probit model. They also discuss the Ratings Markov Chains model as well the Time-Varying Transition Intensities. Finally, the authors present Lando's model with stochastic transition-intensity which can be reinterpreted as a risk-neutral ratings-transition model for bond pricing (chapter 6).

Chapter 5 initiates the discussion on the valuation of default risk. It begins by revising the valuation of zero-coupon defaultable bonds with the assumption of no recovery by bond investors in the event of default. Different models with a recovery rate are presented in chapters

6 and 7. Both reduced form and structural models are discussed in detail in chapter 5. One key assumption is the existence of risk-neutral probabilities under weak no-arbitrage conditions. This helps to compute bond prices in the presence of joint distributions of the default-free term structure and the default time. Differences between actual and risk-neutral default probabilities measure risk premia of different market participants. More generally, a default risk premium reflects risk aversion to the event of default (timing risk) and risk aversion to the conditional loss in the event of default (severity risk). In fact, actual or historical default probabilities are not relevant for bond pricing because these probabilities presume no default-risk premium. They would be relevant only in an economy with risk neutral agents. The difference between actual and risk-neutral default probabilities generates a difference between actual yield spreads and actuarial (risk-neutral) credit spreads. However, the first difference may not be the sole factor explaining the second one. Other factors include partial recovery rates, taxes and market risks (Elton et al., 2001), liquidity risk (Longstaff et al., 2004) and special repo rates (Duffie, 1996). A big challenge is to estimate explicitly the default risk premia for bearing credit risk. At the end of the chapter, the authors discuss approximate mappings between actual and risk neutral probabilities for both reduced-form and structural models.

Chapter 6 introduces nonzero recovery and liquidity issues in the pricing of defaultable bonds, while chapter 7 concerns empirical evidence of pricing models for corporate and sovereign debt. Chapter 6 also makes a link between the term structure of credit spreads for each rating and the stochastic variation in transition intensities.

Chapter 7 starts with an analysis of the links between empirical credit spreads and economic activity. Intuitively we would expect credit spreads to be higher in recessions because default probabilities should be higher and recovery rates should be lower. Isolating this simple intuitive result is not easy, first because available data are not well documented and second because other effects such as variation in liquidity and presence of options may affect the results. Further difficulties are related to different correlations. For example, empirical evidence tends to support "negative correlations between credit spreads and yields on Treasury bonds of comparable maturities" (page 157) as documented by Duffee (1998). Three possible interpretations of this result are analyzed by Duffie and Singleton who obtained the same negative correlations with other data sets: effect of macroeconomic cycles on spreads; difference in liquidity between corporate bonds and Treasury bonds; and change in supply behavior with respect to market conditions.

They then present a model to obtain reference curves for spreads that would be useful for bond pricing. The pricing is obtained by "specifying the risk-neutral joint distribution of the reference curve and the issuer's default- adjusted short-term credit spread process" (page 162). As an example, they propose the swap curve as a reference curve but other reference curves can be used. Parametric reduced-form models and empirical structural models for corporate bond spreads are reviewed and parametric models for sovereign spreads are discussed.

Chapter 8 introduces credit swaps, with special attention to valuation. A credit swap is presented as an insurance coverage against default risk. The bond holder receives a contingent payment at the time of the credit event and pays a premium in the form of an annuity for that protection. Credit swaps are the most actively traded credit derivatives. In the chapter, other forms of credit

derivatives such as collateralized debt obligations (CDOs), total-return swaps, and spread options are also discussed. Spread options are presented in more detail in chapter 9 while CDOs are reviewed in chapter 11. Callable and convertible debts are also analyzed in chapter 9.

Portfolio analysis starts with chapter 10 where correlated defaults are integrated in the analysis. Different formulations of default correlation are discussed in detail. Chapter 12 shows how credit risk affects over-the-counter (OTC) derivatives.

The book ends with integrated market and credit risk measurement. Indeed chapter 13 presents a methodology for integrating the two risks to compute an integrated VaR by considering multiperiod horizons. This model makes a significant extension of commercial credit risk models, by taking into account the dynamic properties of credit spreads and credit quality. In a preliminary exercise the authors review basic concepts of kurtosis (fat tails) and skewness (absence of symmetry) and show that most returns on securities exhibit fat tails and positive or negative skewness. They then analyze in more detail the shape of return distributions, taking into account different approximations that even go beyond Delta and Gamma approximations. Finally, they show how these instruments can be used to implement an integration of market and credit risk. Examples of VaR computation are provided.

I very much enjoyed reading the book. It covers with great competence the relevant topics of credit risk measurement and pricing. The book reflects the strong academic competence of the authors. As already mentioned, this is certainly the best book on credit risk available on the market. I recommend the book to academics and professionals, and also for the teaching of credit risk at Masters and PhD levels in finance and economics.

Many of the developments on the different subjects covered in the book are welcome, since credit risk is still a challenge in the profession. Yield spreads are not fully understood; bonds with options are not adequately modelled even if the authors offer a good introduction to the main issues in chapter 9; business cycles have to be considered more explicitly in long-term analysis particularly if meant to explain yield spreads; recovery rates are still too exogenous, particularly Loss Given Default for loans; and regulatory rules for bank capital tailored to credit risk are not yet able to reduce the gap between regulated and optimal capital.

For the readers of the *Journal of Risk and Insurance* and others I suggest a further extension. In the introduction of the book, Duffie and Singleton suggest that moral hazard and adverse selection are potential candidates for explaining the limited effectiveness of credit-risk allocation, particularly for loans. This remark is based on stylised facts derived from theoretical models in the literature. To our knowledge there are no explicit empirical results in the literature on the presence of residual asymmetric information in financial markets with significant credit risks. Techniques such as those developed in the insurance literature could be extended to financial markets.

I regret only that the authors did not write a conclusion summing up the main open research issues, even though many of them were discussed in the different chapters of the book. So you have to read the book!

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Show abstract. Credit risk is one of the major risk that bank financial institution expose to due to the form of their operations. In this study credit risk will be proxy with nonperforming loans and capital adequacy ratio (Duffie & Singleton, 2012). Nonperforming loans are loans that are in existence for a minimum period of 90 days whose the buyer of the loans are yet to pay either principal or interest due on the loans. ...Â DeRis (Default Risk Information System) is an information system designed to support activities in the management of default risk. The main component is a predictive model of default based on indicators. Currently, the system has been improved allowing models of the TensorFlow tool. Springer, 2017. â€” 250 p. â€” ISBN 978-3319497990. This book introduces to basic and advanced methods for credit risk management. It covers classical debt instruments and modern financial markets products. The author describes not only standard rating and scoring methods like Classification Trees or Logistic Regression, but also less known models that are subject of ongoing research, like e.g. Support Vector Machines, Neural Networks, or Fuzzy Inference Systems. The book also illustrates financial and commodity markets and analyzes the principles of advanced credit risk modeling techniques and cr... August 2, 2019 in Credit Risk Measurement and Management. Credit and Debt Value Adjustments. After completing this reading, you should be able to: Explain the motivation for and the challenges of pricing counterparty risk. Describe credit value adjustment (CVA). Calculate CVA and the CVA spread with no wrong-way risk, netting, or collateralization. Evaluate the impact of changes in the credit spread and recovery rate assumptions on CVA.Â When pricing counterparty risk, best practice calls for clear and well-organized responsibilities where the person or office tasked with the calculation process is specified. Pricing counterparty risk (derivative contracts), however, is a difficult endeavor, particularly when compared to the pricing of bonds.