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Review of "Counterparty Credit Risk by Jon Gregory"

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Counterparty Credit Risk is a must-read for anyone interested or involved in counterparty credit risk (CCR); it is one of the first comprehensive, well-written books on this topic, which has become increasingly important after the recent financial crisis. Jon Gregory effectively covers all the practical aspects of CCR and illustrates its importance as one of the key drivers of the 2007–2009 credit crisis. First published in 2010, *Counterparty Credit Risk* has created some practical consensus among financial institutions and practitioners on how to define, measure, manage, and reduce counterparty credit risk. It has also motivated valuable research, which would hopefully lead to managing the part of *systemic risk* arising from the over-the-counter (OTC) derivatives market.

Basics of CCR Counterparty credit risk (CCR) is the risk that a counterparty in a transaction will default prior to expiration of a trade and will not, therefore, make the payments required by the contract. Counterparty risk is typically considered and quantified in two broad classes of financial products: OTC derivatives and securities financing transactions. Chapter 1 and 2 of *Counterparty Credit Risk* illustrate why CCR is considered to be the most complex form of credit risk as it also involves market risk, liquidity risk, and operational risk. The loss that a financial institution would incur due to the default of its counterparty to a derivative contract depends on the value of the contract to the financial institution (dealer) at the time of the default. The value of the contract to the dealer at the default time could be positive or negative; the positive part (which will be lost due to the counterparty's default and is to be replaced) is referred to as *credit exposure*. Measuring and managing counterparty risk is challenging due to the bilateral nature of CCR and because of this dynamic interplay between credit and market risk. Chapters 1 to 5 cover many of the important and practical aspects of CCR, some of which are quite subtle. For instance, that netting and collateralization, two widely used means of reducing and mitigating counterparty risk, could lead to operational and liquidity risk has been effectively pointed out by Jon Gregory, (for instance, consider an extreme example where the dealer calls for non-cash collateral on a daily basis from its relatively low-credit-quality hedge fund counterparty).

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Accessibility of the Book To make the book accessible to "non-quantitative" readers, the more technical material has been mainly included in the appendices of each chapter. This style, I believe, has been effective for most parts of the book. However, I believe that the mathematics involved in credit derivative pricing (last parts of Chapter 6), and counterparty credit risk pricing (Chapters 7 and 8), is essential for a solid understanding of these topics. For instance, since the valuation of credit default swap (CDS) contracts is model dependent, it is quite challenging to communicate the essentials of CDS pricing without using some basic probability theory. Or, as another example, it is difficult to effectively define bilateral credit value adjustment (CVA) (see [8]) for the "non-quantitative" audience.

Challenges and the Future of Counterparty Risk In the final chapter of *Counterparty Credit Risk*, Jon Gregory discusses the future of counterparty risk and addresses topics that have indeed become the future of counterparty risk. In what follows, I will consider some general but critical aspects of two of these topics: Central Clearing Counterparties (CCP) and CVA, and at the end I will comment on the importance of statistical efficiency analysis in counterparty credit risk.

Central Clearing Counterparties Large financial institutions experienced substantial OTC derivative losses during the 2007–2009 financial crisis. To manage and reduce the systemic risk arising from the OTC derivatives market, regulators are requiring that some OTC derivatives transactions move to central clearing houses. A CCP, which stands between the "market buyer and seller", is an institution designed to insure counterparty risk. It manages the credit risk of both parties in part by requiring an initial margin and calculating daily variations margins, (see [4] and [3]). Chapter 14 of *Counterparty Credit Risk* carefully discusses many of the advantages and disadvantages of centralized clearing. However, it does not take into account one crucial point when considering the question of whether the OTC derivatives market should be cleared by one or more than one CCP's: (directly) reducing counterparty risk is not the only objective of CCP's. In parallel with directly reducing counterparty risk, CCP's are designed to increase the transparency of the relatively opaque OTC markets. The opacity surrounding OTC markets has contributed significantly to the failure of large financial institutions such as Bear Stearns, Lehman Brothers, and AIG, (see Part 4 of [1]), and CCP's are to make the OTC markets safer by reducing this lack of transparency.

When analyzing the role of CCP's in reducing counterparty risk, Jon Gregory considers the *CCP failure* as one of the disadvantages of centralized clearing. This is indeed the case that CCP's concentrate the aggregate counterparty risk and would become too-big-to-fail. However, the *CCP failure* problem could be dealt with by improving their design. For instance, Koeppl and Monnet [10] propose to complement the traditional CCP clearing with a systemic risk insurance fund that is financed through a tax on dealers' net derivatives positions. This fund internalizes the costs of defaults in terms of systemic risk and acts like insurance against systemic risk at the same time. Another potential disadvantage of CCP's, which has been wisely and appropriately emphasized in Chapter 14 of *Counterparty Credit Risk*, is that with CCP's in place, financial institutions would have little incentive to monitor their counterpartys' credit quality and their default risk and so would tend to take on additional risks. In their interesting systemic-risk-insurance-fund proposal, Koeppl and Monnet also recognize and deal with this "incentive" problem. That is, it seems that a good CCP design could potentially eliminate both the default-risk-incentive problem and too-big-to-fail problem. So, it seems that these two disadvantages should not be used against the recent regulatory attempt of moving some OTC derivatives to CCP's that are to be well-designed.

Wrong Way Risk and Credit Value Adjustment Wrong way (right way) exposures are first defined by Canabarro and Duffie [2] as credit exposures that are negatively (positively) correlated with the credit quality of the counterparty. Jon Gregory (see Chapter 8 of [7]; page 207) writes: "the presence of wrong way risk will (unsurprisingly) increase CVA", and this notion has been used at several occasions in *Counterparty Credit Risk*. This view of wrong way CVA is in fact quite popular among practitioners.[1] Ghamami and Goldberg [5] show that the presence of wrong way risk does not necessarily increase CVA in a particular class of stochastic intensity models of wrong way risk.

Mathematical modeling of wrong way risk in CVA calculations is subtle and challenging; depending on the mathematical model and the calibration strategy wrong way risk may or may not increase CVA.

Consider a portfolio of derivative contracts that a financial institution holds against its counterparty. Let V_t denote the credit exposure to the counterparty at time $t > 0$. CVA, the price of counterparty credit risk, is the difference between the risk free portfolio value and the true counterparty default risky portfolio value, (see [12] or chapter 7 of [7]). Let τ, a positive random variable, denote the default time of the counterparty. It can be shown that (unilateral) credit value adjustment is the risk neutral expected discounted loss, i.e.,

$$\text{CVA} \equiv E[(1-R)D_\tau V_\tau \mathbf{1}\{\tau \leq T\}], \tag{1}$$

where $1\{A\}$ is indicator of the event A, D_t is the stochastic discount factor at time t, and R is the rate of recovery. Using the above notation, wrong way risk is present when, for instance, an increasing sample path of the process V in the interval $[0, T]$ affects the distribution of τ and makes the counterparty more likely to default. That is, wrong way risk can be viewed as a *path-wise* definition. CVA, however, as shown above, is an average-type measure. Ghamami and Goldberg [5] use a stochastic intensity approach, first considered by Hull and White [9], where this path-wise definition of wrong way risk is captured mathematically. However, their numerical examples indicate that CVA in the presence of wrong way risk need not exceed independent CVA (CVA in the absence of wrong way risk and when V and τ are independent).[2]

[1] The author of this review has been formerly employed by a large investment bank and has had recent discussions with counterparty credit risk divisions of some of the major investment banks.

[2] Jon Gregory in Chapter 9 of *Counterparty Credit Risk* argues that "pricing counterparty risk should not be necessarily considered in a risk-neutral context", (see page 248 of [7]). Consensus does not still exist around this topic among practitioners and academicians. The numerical examples of [5] do not use the risk-neutral measure when sampling from the underlying risk factors to estimate the CVA with Monte Carlo simulation.

Statistical Efficiency Analysis of the Monte Carlo CCR Estimators Monte Carlo simulation is widely used to estimate various types of counterparty credit measures, (see Chapter 4 of [7]); it is well-known that Monte Carlo estimation of CCR is extremely computationally intensive, (see [2], [12], and [6]). Computational budget of financial institutions is not limitless, and so in the absence of careful analysis of the statistical properties and computational time of the widely used CCR estimators, given a fixed computational budget, counterparty risk could be significantly underestimated or overestimated depending on the parameter space of the credit exposure process and counterparty's default time distribution. While Chapters 4 and 5 of *Counterparty Credit Risk* carefully explain various challenges in quantifying and modeling counterparty credit exposure, I believe that the above-mentioned practical aspect of CCR has not been emphasized in *Counterparty Credit Risk*.

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