

Contents

Ignition	xv
Abbreviations and Notation	xxiii
PART I COUNTERPARTY CREDIT RISK, COLLATERAL AND FUNDING	
1 Introduction	3
1.1 A Dialogue on CVA	3
1.2 Risk Measurement: Credit VaR	3
1.3 Exposure, CE, PFE, EPE, EE, EAD	5
1.4 Exposure and Credit VaR	7
1.5 Interlude: P and Q	7
1.6 Basel	8
1.7 CVA and Model Dependence	9
1.8 Input and Data Issues on CVA	10
1.9 Emerging Asset Classes: Longevity Risk	11
1.10 CVA and Wrong Way Risk	12
1.11 Basel III: VaR of CVA and Wrong Way Risk	13
1.12 Discrepancies in CVA Valuation: Model Risk and Payoff Risk	14
1.13 Bilateral Counterparty Risk: CVA and DVA	15
1.14 First-to-Default in CVA and DVA	17
1.15 DVA Mark-to-Market and DVA Hedging	18
1.16 Impact of Close-Out in CVA and DVA	19
1.17 Close-Out Contagion	20
1.18 Collateral Modelling in CVA and DVA	21
1.19 Re-Hypothecation	22
1.20 Netting	22
1.21 Funding	23
1.22 Hedging Counterparty Risk: CCDS	25
1.23 Restructuring Counterparty Risk: CVA-CDOs and Margin Lending	26

2	Context	31
2.1	Definition of Default: Six Basic Cases	31
2.2	Definition of Exposures	32
2.3	Definition of Credit Valuation Adjustment (CVA)	35
2.4	Counterparty Risk Mitigants: Netting	37
2.5	Counterparty Risk Mitigants: Collateral	38
2.5.1	The Credit Support Annex (CSA)	39
2.5.2	The ISDA Proposal for a New Standard CSA	40
2.5.3	Collateral Effectiveness as a Mitigant	40
2.6	Funding	41
2.6.1	A First Attack on Funding Cost Modelling	42
2.6.2	The General Funding Theory and its Recursive Nature	42
2.7	Value at Risk (VaR) and Expected Shortfall (ES) of CVA	43
2.8	The Dilemma of Regulators and Basel III	44
3	Modelling the Counterparty Default	47
3.1	Firm Value (or Structural) Models	47
3.1.1	The Geometric Brownian Assumption	47
3.1.2	Merton's Model	48
3.1.3	Black and Cox's (1976) Model	50
3.1.4	Credit Default Swaps and Default Probabilities	54
3.1.5	Black and Cox (B&C) Model Calibration to CDS: Problems	55
3.1.6	The AT1P Model	57
3.1.7	A Case Study with AT1P: Lehman Brothers Default History	58
3.1.8	Comments	60
3.1.9	SBTV Model	61
3.1.10	A Case Study with SBTV: Lehman Brothers Default History	62
3.1.11	Comments	64
3.2	Firm Value Models: Hints at the Multiname Picture	64
3.3	Reduced Form (Intensity) Models	65
3.3.1	CDS Calibration and Intensity Models	66
3.3.2	A Simpler Formula for Calibrating Intensity to a Single CDS	70
3.3.3	Stochastic Intensity: The CIR Family	72
3.3.4	The Cox-Ingersoll-Ross Model (CIR) Short-Rate Model for r	72
3.3.5	Time-Inhomogeneous Case: CIR++ Model	74
3.3.6	Stochastic Diffusion Intensity is Not Enough: Adding Jumps. The JCIR(++) Model	75
3.3.7	The Jump-Diffusion CIR Model (JCIR)	76
3.3.8	Market Incompleteness and Default Unpredictability	78
3.3.9	Further Models	78
3.4	Intensity Models: The Multiname Picture	78
3.4.1	Choice of Variables for the Dependence Structure	78
3.4.2	Firm Value Models?	80
3.4.3	Copula Functions	80
3.4.4	Copula Calibration, CDOs and Criticism of Copula Functions	86

PART II PRICING COUNTERPARTY RISK: UNILATERAL CVA

4	Unilateral CVA and Netting for Interest Rate Products	89
4.1	First Steps towards a CVA Pricing Formula	89
4.1.1	Symmetry versus Asymmetry	90
4.1.2	Modelling the Counterparty Default Process	91
4.2	The Probabilistic Framework	92
4.3	The General Pricing Formula for Unilateral Counterparty Risk	94
4.4	Interest Rate Swap (IRS) Portfolios	97
4.4.1	Counterparty Risk in Single IRS	97
4.4.2	Counterparty Risk in an IRS Portfolio with Netting	100
4.4.3	The Drift Freezing Approximation	102
4.4.4	The Three-Moments Matching Technique	104
4.5	Numerical Tests	106
4.5.1	Case A: IRS with Co-Terminal Payment Dates	106
4.5.2	Case B: IRS with Co-Starting Resetting Date	108
4.5.3	Case C: IRS with First Positive, Then Negative Flow	108
4.5.4	Case D: IRS with First Negative, Then Positive Flows	109
4.5.5	Case E: IRS with First Alternate Flows	113
4.6	Conclusions	120
5	Wrong Way Risk (WWR) for Interest Rates	121
5.1	Modelling Assumptions	122
5.1.1	G2++ Interest Rate Model	122
5.1.2	CIR++ Stochastic Intensity Model	123
5.1.3	CIR++ Model: CDS Calibration	124
5.1.4	Interest Rate/Credit Spread Correlation	126
5.1.5	Adding Jumps to the Credit Spread	126
5.2	Numerical Methods	127
5.2.1	Discretization Scheme	128
5.2.2	Simulating Intensity Jumps	128
5.2.3	“American Monte Carlo” (Pallavicini 2006)	128
5.2.4	Callable Payoffs	128
5.3	Results and Discussion	129
5.3.1	WWR in Single IRS	129
5.3.2	WWR in an IRS Portfolio with Netting	129
5.3.3	WWR in European Swaptions	130
5.3.4	WWR in Bermudan Swaptions	130
5.3.5	WWR in CMS Spread Options	132
5.4	Contingent CDS (CCDS)	132
5.5	Results Interpretation and Conclusions	133
6	Unilateral CVA for Commodities with WWR	135
6.1	Oil Swaps and Counterparty Risk	135
6.2	Modelling Assumptions	137
6.2.1	Commodity Model	137
6.2.2	CIR++ Stochastic-Intensity Model	139

6.3	Forward versus Futures Prices	140
6.3.1	CVA for Commodity Forwards without WWR	141
6.3.2	CVA for Commodity Forwards with WWR	142
6.4	Swaps and Counterparty Risk	142
6.5	UCVA for Commodity Swaps	144
6.5.1	Counterparty Risk from the Payer's Perspective: The Airline Computes Counterparty Risk	145
6.5.2	Counterparty Risk from the Receiver's Perspective: The Bank Computes Counterparty Risk	148
6.6	Inadequacy of Basel's WWR Multipliers	148
6.7	Conclusions	151
7	Unilateral CVA for Credit with WWR	153
7.1	Introduction to CDSs with Counterparty Risk	153
7.1.1	The Structure of the Chapter	155
7.2	Modelling Assumptions	155
7.2.1	CIR++ Stochastic-Intensity Model	156
7.2.2	CIR++ Model: CDS Calibration	157
7.3	CDS Options Embedded in CVA Pricing	158
7.4	UCVA for Credit Default Swaps: A Case Study	160
7.4.1	Changing the Copula Parameters	160
7.4.2	Changing the Market Parameters	164
7.5	Conclusions	164
8	Unilateral CVA for Equity with WWR	167
8.1	Counterparty Risk for Equity Without a Full Hybrid Model	167
8.1.1	Calibrating ATIP to the Counterparty's CDS Data	168
8.1.2	Counterparty Risk in Equity Return Swaps (ERS)	169
8.2	Counterparty Risk with a Hybrid Credit-Equity Structural Model	172
8.2.1	The Credit Model	172
8.2.2	The Equity Model	174
8.2.3	From Barrier Options to Equity Pricing	176
8.2.4	Equity and Equity Options	179
8.3	Model Calibration and Empirical Results	180
8.3.1	BP and FIAT in 2009	181
8.3.2	Uncertainty in Market Expectations	186
8.3.3	Further Results: FIAT in 2008 and BP in 2010	188
8.4	Counterparty Risk and Wrong Way Risk	191
8.4.1	Deterministic Default Barrier	193
8.4.2	Uncertainty on the Default Barrier	198
9	Unilateral CVA for FX	205
9.1	Pricing with Two Currencies: Foundations	206
9.2	Unilateral CVA for a Fixed-Fixed CCS	210
9.2.1	Approximating the Volatility of Cross Currency Swap Rates	216
9.2.2	Parameterization of the FX Correlation	218

9.3	Unilateral CVA for Cross Currency Swaps with Floating Legs	224
9.4	Why a Cross Currency Basis?	226
9.4.1	The Approach of Fujii, Shimada and Takahashi (2010)	227
9.4.2	Collateral Rates versus Risk-Free Rates	228
9.4.3	Consequences of Perfect Collateralization	229
9.5	CVA for CCS in Practice	230
9.5.1	Changing the CCS Moneyiness	234
9.5.2	Changing the Volatility	235
9.5.3	Changing the FX Correlations	235
9.6	Novations and the Cost of Liquidity	237
9.6.1	A Synthetic Contingent CDS: The Novation	238
9.6.2	Extending the Approach to the Valuation of Liquidity	241
9.7	Conclusions	243
PART III ADVANCED CREDIT AND FUNDING RISK PRICING		
10	New Generation Counterparty and Funding Risk Pricing	247
10.1	Introducing the Advanced Part of the Book	247
10.2	What We Have Seen Before: Unilateral CVA	249
10.2.1	Approximation: Default Bucketing and Independence	250
10.3	Unilateral Debit Valuation Adjustment (UDVA)	250
10.4	Bilateral Risk and DVA	251
10.5	Undesirable Features of DVA	253
10.5.1	Profiting From Own Deteriorating Credit Quality	253
10.5.2	DVA Hedging?	253
10.5.3	DVA: Accounting versus Capital Requirements	254
10.5.4	DVA: Summary and Debate on Realism	255
10.6	Close-Out: Risk-Free or Replacement?	256
10.7	Can We Neglect the First-to-Default Time?	257
10.7.1	A Simplified Formula without First-to-Default: The Case of an Equity Forward	258
10.8	Payoff Risk	258
10.9	Collateralization, Gap Risk and Re-Hypothecation	259
10.10	Funding Costs	262
10.11	Restructuring Counterparty Risk	263
10.11.1	CVA Volatility: The Wrong Way	263
10.11.2	Floating Margin Lending	264
10.11.3	Global Valuation	265
10.12	Conclusions	266
11	A First Attack on Funding Cost Modelling	269
11.1	The Problem	269
11.2	A Closer Look at Funding and Discounting	271
11.3	The Approach Proposed by Morini and Prampolini (2010)	272
11.3.1	The Borrower's Case	273
11.3.2	The Lender's Case	274

11.3.3	The Controversial Role of DVA: The Borrower	275
11.3.4	The Controversial Role of DVA: The Lender	276
11.3.5	Discussion	277
11.4	What Next on Funding?	278
12	Bilateral CVA–DVA and Interest Rate Products	279
12.1	Arbitrage-Free Valuation of Bilateral Counterparty Risk	281
12.1.1	Symmetry versus Asymmetry	285
12.1.2	Worsening of Credit Quality and Positive Mark-to-Market	285
12.2	Modelling Assumptions	286
12.2.1	G2++ Interest Rate Model	286
12.2.2	CIR++ Stochastic Intensity Model	288
12.2.3	Realistic Market Data Set for CDS Options	289
12.3	Numerical Methods	290
12.4	Results and Discussion	291
12.4.1	Bilateral VA in Single IRS	292
12.4.2	Bilateral VA in an IRS Portfolio with Netting	296
12.4.3	Bilateral VA in Exotic Interest Rate Products	301
12.5	Conclusions	302
13	Collateral, Netting, Close-Out and Re-Hypothecation	305
13.1	Trading Under the ISDA Master Agreement	306
13.1.1	Mathematical Setup and CBVA Definition	306
13.1.2	Collateral Delay and Dispute Resolutions	308
13.1.3	Close-Out Netting Rules	308
13.1.4	Collateral Re-Hypothecation	309
13.2	Bilateral CVA Formula under Collateralization	310
13.2.1	Collecting CVA Contributions	310
13.2.2	CBVA General Formula	312
13.2.3	CCVA and CDVA Definitions	312
13.3	Close-Out Amount Evaluation	313
13.4	Special Cases of Collateral-Inclusive Bilateral Credit Valuation Adjustment	314
13.5	Example of Collateralization Schemes	315
13.5.1	Perfect Collateralization	315
13.5.2	Collateralization Through Margining	316
13.6	Conclusions	316
14	Close-Out and Contagion with Examples of a Simple Payoff	319
14.1	Introduction to Close-Out Modelling and Earlier Work	319
14.1.1	Close-Out Modelling: Context	319
14.1.2	Legal Documentation on Close-Out	320
14.1.3	Literature	320
14.1.4	Risk-Free versus Replacement Close-Out: Practical Consequences	321

	Contents	xiii
14.2	Classical Unilateral and Bilateral Valuation Adjustments	322
14.3	Bilateral Adjustment and Close-Out: Risk-Free or Replacement?	323
14.4	A Quantitative Analysis and a Numerical Example	323
14.4.1	Contagion Issues	326
14.5	Conclusions	329
15	Bilateral Collateralized CVA and DVA for Rates and Credit	331
15.1	CBVA for Interest Rate Swaps	332
15.1.1	Changing the Margining Frequency	332
15.1.2	Inspecting the Exposure Profiles	334
15.1.3	A Case Where Re-Hypothecation is Worse than No Collateral at All	335
15.1.4	Changing the Correlation Parameters	336
15.1.5	Changing the Credit Spread Volatility	337
15.2	Modelling Credit Contagion	340
15.2.1	The CDS Price Process	340
15.2.2	Calculation of Survival Probability	341
15.2.3	Modelling Default-Time Dependence	344
15.3	CBVA for Credit Default Swaps	345
15.3.1	Changing the Copula Parameters	345
15.3.2	Inspecting the Contagion Risk	347
15.3.3	Changing the CDS Moneyiness	347
15.4	Conclusions	349
16	Including Margining Costs in Collateralized Contracts	351
16.1	Trading Under the ISDA Master Agreement	352
16.1.1	Collateral Accrual Rates	352
16.1.2	Collateral Management and Margining Costs	353
16.2	CBVA General Formula with Margining Costs	355
16.2.1	Perfect Collateralization	356
16.2.2	Futures Contracts	357
16.3	Changing the Collateralization Currency	357
16.3.1	Margining Cost in Foreign Currency	357
16.3.2	Settlement Liquidity Risk	358
16.3.3	Gap Risk in Single-Currency Contracts with Foreign-Currency Collaterals	359
16.4	Conclusions	359
17	Funding Valuation Adjustment (FVA)?	361
17.1	Dealing with Costs of Funding	361
17.1.1	Central Clearing, CCPs and this Book	362
17.1.2	High Level Features	362
17.1.3	Single-Deal (Micro) vs. Homogeneous (Macro) Funding Models	363
17.1.4	Previous Literature on Funding and Collateral	364
17.1.5	Including FVA along with Credit and Debit Valuation Adjustment	365
17.1.6	FVA is not DVA	365

17.2	Collateral- and Funding-Inclusive Bilateral Valuation Adjusted Price	366
17.3	Funding Risk and Liquidity Policies	367
17.3.1	Funding, Hedging and Collateralization	367
17.3.2	Liquidity Policies	368
17.4	CBVA Pricing Equation with Funding Costs (CFBVA)	372
17.4.1	Iterative Solution of the CFBVA Pricing Equation	373
17.4.2	Funding Derivative Contracts in a Diffusion Setting	374
17.4.3	Implementing Hedging Strategies via Derivative Markets	377
17.5	Detailed Examples	378
17.5.1	Funding with Collateral	378
17.5.2	Collateralized Contracts Priced by a CCP	379
17.5.3	Dealing with Own Credit Risk: FVA and DVA	380
17.5.4	Deriving Earlier Results on FVA and DVA	381
17.6	Conclusions: FVA and Beyond	382
18	Non-Standard Asset Classes: Longevity Risk	385
18.1	Introduction to Longevity Markets	385
18.1.1	The Longevity Swap Market	385
18.1.2	Longevity Swaps: Collateral and Credit Risk	386
18.1.3	Indexed Longevity Swaps	390
18.1.4	Endogenous Credit Collateral and Funding-Inclusive Swap Rates	390
18.2	Longevity Swaps: The Payoff Π	391
18.3	Mark-to-Market for Longevity Swaps	394
18.4	Counterparty and Own Default Risk, Collateral and Funding	397
18.5	An Example of Modelling Specification from Biffis et al. (2011)	401
18.6	Discussion of the Results in Biffis et al. (2011)	404
19	Conclusions and Further Work	409
19.1	A Final Dialogue: Models, Regulations, CVA/DVA, Funding and More	409
	Bibliography	415
	Index	423