

Operational

Risk



*A Guide to Basel II Capital
Requirements, Models, and Analysis*

ANNA S. CHERNOBAI
SVETLOZAR T. RACHEV
FRANK J. FABOZZI



John Wiley & Sons, Inc.

Contents

Preface	xv
About the Authors	xix
CHAPTER 1	
Operational Risk Is Not Just "Other" Risks	1
Effects of Globalization and Deregulation: Increased Risk	
Exposures	2
Examples of High-Magnitude Operational Losses	4
Orange County, 1994, United States	5
Barings Bank, 1995, United Kingdom	5
Daiwa Bank, 1995, New York	7
Allied Irish Banks, 2002, Ireland	8
The Enron Scandal, 2001, United States	8
MasterCard International, 2005, United States	9
Terrorist Attack, September 11, 2001, New York and Worldwide	10
Operational Losses in The Hedge Fund Industry	10
Summary of Key Concepts	12
References	12
CHAPTER 2	
Operational Risk: Definition, Classification, and Its Place among Other Risks	15
What Is Risk?	15
Definition of Operational Risk	16
Operational Risk Exposure Indicators	18
Classification of Operational Risk	19
Internal versus External Operational Losses	19
Direct versus Indirect Operational Losses	19
Expected versus Unexpected Operational Losses	22
Operational Risk Type, Event Type, and Loss Type	22
Operational Loss Severity and Frequency	23

Topology of Financial Risks	26
Capital Allocation for Operational, Market, and Credit Risks	29
Impact of Operational Risk on the Market Value of Bank Equity	30
Effects of Macroeconomic Environment on Operational Risk	31
Summary of Key Concepts	31
References	32
CHAPTER 3	
Basel II Capital Accord	35
The Basel Committee on Banking Supervision	35
The Basel Capital Accord	36
Pillar I: Minimum Capital Requirements for Operational Risk	37
Decomposition of Capital	37
Capital for Expected and Unexpected Losses	39
Three Approaches to Assess the Operational Risk Capital Charge	40
The Basic Indicator Approach	41
The Standardized Approach	42
The Advanced Measurement Approaches	44
Pillar II: Capital Adequacy and Regulatory Principles	47
Pillar III: Market Discipline and Public Disclosure	48
Overview of Loss Data Collection Exercises	49
The Role of Insurance	51
Which Operational Losses Should Be Transferred?	53
FIORI Insurance Policy by Swiss Re	54
Insurance Recoveries Data from the 2002 Loss Data Collection Exercise	54
Limitations of Insurance	55
Policy Limit	55
High Costs of Insurance	55
Moral Hazard	55
Alternatives to Insurance	57
Catastrophe Options	58
Catastrophe Bonds	58
Compliance with Basel II in Practice	59
JPMorgan Chase	59
HBOS	61
Implementing Basel II: Some General Concerns	61
Summary of Key Concepts	63
References	64

CHAPTER 4

Key Challenges in Modeling Operational Risk	07
Operational Risk Models	67
Models Based on Top-Down Approaches	69
Multifactor Equity Pricing Models	69
Capital Asset Pricing Model	69
Income-Based Models	70
Expense-Based Models	70
Operating Leverage Models	70
Scenario Analysis and Stress Testing Models	70
Risk Indicator Models	71
Models Based on Bottom-Up Approaches	72
Process-Based Models	72
Actuarial Models	74
Proprietary Models	75
Specifics of Operational Loss Data	75
Scarcity of Available Historical Data	76
Data Arrival Process	77
Loss Severity Process	78
Dependence between Business Units	81
Summary of Key Concepts	81
References	82

CHAPTER 5

Frequency Distributions	85
Binomial Distribution	86
Geometric Distribution	87
Poisson Distribution	88
Negative Binomial Distribution	92
Nonhomogeneous Poisson Process (Cox Process)	92
Mixture Distributions	93
Nonhomogeneous Poisson Process with Stochastic Intensity	93
Algorithm 1	93
Algorithm 2	94
Alternative Approach: Interarrival Times Distribution	94
Empirical Analysis with Operational Loss Data	95
Studies with Real Data	95
Cruz Study of Fraud Loss Data	95
Moscadelli Study of 2002 LDCE Operational Loss Data	97

De Fontnouvelle, Rosengren, and Jordan Study of 2002 LDCE Operational Loss Data	98
Lewis and Lantsman Study of Unauthorized Trading Data	99
Chernobai, Burnecki, Rachev, Truck, and Weron Study of U.S. Natural Catastrophe Insurance 'Claims Data	99
Chernobai, Menn, Rachev, and Truck Study of 1980-2002 Public Operational Loss Data	99
Chernobai and Rachev Study of 1950-2002 Public Operational Loss Data	101
Studies with Simulated Data	103
Laycock Study of Mishandling Losses and Processing Errors Data	103
Cruz Study with Internal Fraud Data	103
Summary of Key Concepts	105
Appendix: Basic Descriptive Techniques for Discrete Random Variables	105
Sample	106
Population	106
References	109

CHAPTER 6

Loss Distributions	111
Nonparametric Approach: Empirical Distribution Function	113
Parametric Approach: Continuous Loss Distributions	114
Exponential Distribution	115
Lognormal Distribution	116
Weibull Distribution	117
Gamma Distribution	119
Beta Distribution	120
Pareto Distribution	122
Burr Distribution	123
Extension: Mixture Loss Distributions	125
A Note on the Tail Behavior	127
Empirical Evidence with Operational Loss Data	129
Studies with Real Data	129
Muller Study of 1950-2002 Operational Loss Data	129
Cruz Study of Legal Loss Data	130
Moscadelli Study of 2002 LDCE Operational Loss Data	132

De Fontnouvelle, Rosengren, and Jordan Study of 2002 LDCE Operational Loss Data	134
Lewis Study of Legal Liability Loss Data	135
Studies with Simulated Data	135
Reynolds and Syer Study	135
Rosenberg and Schuermann Study	136
Summary of Key Concepts	136
Appendix: Basic Descriptive Techniques for Continuous Random Variables	137
Sample	137
Population	140
Transformations of Random Variables	142
Parameter Estimation Methods	143
References	144

CHAPT B17

Alpha-Stable Distributions	147
Definition of an Alpha-Stable Random Variable	148
Useful Properties of an Alpha-Stable Random Variable	150
Estimating Parameters of the Alpha-Stable Distribution	152
Sample Characteristic Function Approach	152
Numerical Approximation of the Density Function Approach	153
Useful Transformations of Alpha-Stable Random Variables	153
Symmetric Alpha-Stable Random Variable	153
Log-Alpha-Stable Random Variable	154
Truncated Alpha-Stable Random Variable	154
Applications to Operational Loss Data	154
Chernobai, Menn, Rachev, and Truck Study of 1980-2002 Public Loss Data	155
Chernobai and Rachev Study of 1950-2002 Public Loss Data	157
Summary of Key Concepts	158
Appendix: Characteristic Functions -	158
Definition of Characteristic Functions	159
Some Properties of Characteristic Functions	160
Relation to Distribution Functions	161
References	161

CHAPTER 8

Extreme Value Theory	103
Block Maxima Model	163

Empirical Studies with Operational Loss Data	237
De Fontnouvelle, Rosengren, and Jordan Study of 2002	
LDCE Data	238
Chapelle, Crama, Hiibner, and Peters Study with	
European Loss Data	239
Summary of Key Concepts	240
References	241
CHAPTER 12	
Robust Modeling	245
Outliers in Operational Loss Data	246
Some Dangers of Using the Classical Approach	248
Overview of Robust Statistics Methodology	248
Formal Model for Robust Statistics	249
Traditional Methods of Outlier Detection	249
Examples of Nonrobust versus Robust Estimators	251
Outlier Detection Approach Based on Influence	
Functions	251
Advantages of Robust Statistics	252
Outlier Rejection Approach and Stress Tests	252
Application of Robust Methods to Operational Loss Data	253
Summary of Key Concepts	255
References	256
CHAPTHM3	
Modeling Dependence	259
Three Types of Dependence in Operational Risk	260
Linear Correlation	261
Covariance and Its Properties	261
Correlation and Its Properties	262
Aggregate Loss Correlation When Only Frequencies	
Are Dependent	264
Drawbacks of Linear Correlation	265
Alternative Dependence Measure: Rank Correlation	265
Copulas	266
Definition of Copula	266
Examples of Copulas	267
Using Copulas to Aggregate Credit, Market, and Operational	
Risks	272
Empirical Studies with Operational Loss Data	272
Chapelle, Crama, Hiibner, and Peters Study	272
Dalla Valle, Fantazzini, and Giudici Study	274

Contents

r

XIH

Kuritzkes, Schuermann, and Weiner Study	277
Rosenberg and Schuermann Study	278
Summary of Key Concepts	281
References	282

Index

285