## **Contents Overview**

Pre	face	V
Abo	out the authors	IX
Lis	t of abbreviations and symbols X	XIX
Lis	t of figures	αXV
Lis	t of tables	LIII
Mo	dule I Fundamentals	1
1	Financial engineering – business segment with a future	3
2	Review of the methodological foundations of financial engineering	17
3	Ethical principles for successful financial engineering	73
Mo	dule II Listed options & futures	85
4	Derivatives exchanges and derivatives markets	87
5	Futures – unconditional derivatives contracts	123
6	Options – conditional derivatives contracts	161
7	Derivatives on currencies and commodities	261
Mo	dule III Structured derivatives	297
8	Exotic and non-listed derivatives	299
9	Credit derivatives	357
10	Weather derivatives	375
11	Insurance derivatives	409
12	Real ontions	415



Module IV Application of derivatives		437
3 Structuring complex portfolios with the help of derivatives		439
4 Use of derivatives in financial engineering and fund manage	ement	457
5 What is a hedge fund?		483
6 Risk controlling and margining		501
n closing		527
7 Appendix		531
References		565
Disclaimer		569
ndex		573

## **Contents**

Pre	face	· · · · · · · · · · · · · · · · · · ·	7
Abo	out the	authors	<
List	of ab	breviations and symbols XXIX	<
List	of fig	rures	7
List	of tal	oles	Ι
Мо	dule I	Fundamentals	1
1	Finan	cial engineering – business segment with a future	3
•	1.1		3
	1.2	8	4
	1.3	1 0 0	4
	1.4	Which theories and models are combined in financial	
			6
	1.5		6
	1.6		8
			8
			8
	1.7		9
	1.8	Issuers	9
	1.9	Which product and when?	0
	1.10	What likely development lies ahead for financial	
		engineering?	2
2	Revie	w of the methodological foundations of financial	
		eering	7
	2.1	Foundations of probability theory 1'	7
		2.1.1 Laplace probability	8
		2.1.2 Frequentist probability	9
		2.1.3 Subjective probability	9
		2.1.4 Conditional probability	9

XIV Contents

2.2	Stocha	stic processes	23	
	2.2.1	Markov process	23	
	2.2.1	.1 Wiener process	23	
	2.2.1	.2 Generalized Wiener process	23	
	2.2.2	Itō process	25	
	2.2.3	The normal distribution	26	
	2.2.4	Martingale assumption	28	
	2.2.5	Random walk	28	
2.3	Correla	ation analysis	30	
	2.3.1	Correlation	30	
	2.3.2	Variance, covariance and correlation coefficients	33	
2.4	Statisti	cal concepts of security analysis	35	
	2.4.1	Calculation of the beta factor	35	
	2.4.2	Log-normal distribution of equity prices 3	37	
	2.4.3	Valuation using replication	39	
2.5	Value a	at Risk	10	
	2.5.1	Graphical derivation	12	
	2.5.2	Analytical models	14	
	2.5.3	Simulation models	14	
2.6	Foundations and approaches of decision theory			
	2.6.1	Classical decision theory	15	
	2.6.2	Game theory	16	
2.7	Who k	nows what?	17	
	2.7.1	Complete information	<b>1</b> 7	
	2.7.2	Perfect information	17	
	2.7.3	Transformation of games with incomplete		
		information into games with complete, but		
		imperfect information	<b>1</b> 7	
	2.7.4	Different strategies	17	
	2.7.4	Pure and mixed strategies	17	
	2.7.4	2.2 Equilibria in dominant strategies	18	
	2.7.4	Nash equilibrium	18	
2.8	Solutio	on strategies for known decision situations 4	18	
	2.8.1	Financial engineering and game theory 4	19	
	2.8.2	Portfolio risk management	50	
	2.8.3	Fundamental questions for every investor	51	
	2.8.3	.1 The different types of investors	53	
	2.8.3	.2 How to approach derivatives as an		
			53	
	2.8.4	Portfolio theory	55	
	2.8.4		55	

Contents XV

		2.8.4.2 Single index model	57		
		2.8.4.3 Capital Asset Pricing Model (CAPM)	58		
		2.8.4.3.1 Assumptions of CAPM	58		
		2.8.4.3.2 Main conclusions of CAPM	59		
		2.8.4.3.3 Summary of the CAPM	62		
		2.8.5 Final assessment of the models	62		
		2.8.6 The process of portfolio management	63		
	2.9	Market psychology and behavioral economics	64		
		2.9.1 Market psychology	64		
		2.9.2 Behavioral economics	65		
		2.9.3 Methods of behavioral finance	66		
		2.9.3.1 Herd behavior	67		
		2.9.3.2 Group thinking	68		
		2.9.4 Closing thoughts	68		
3	Ethica	al principles for successful financial engineering	73		
	3.1	Are ethics enforcable in finance?	74		
	3.2	What is important in financial engineering concerning			
		ethics?			
		3.2.1 The financial engineer as competent partner	75		
		3.2.2 The financial engineer as creator of tangible			
		solutions	76		
		3.2.3 The financial engineer as judge of the doable	76		
	3.3	How to check for ethical principles?	78		
	3.4	Fundamental ethical points of reference for the financial			
		engineer	78		
Mo	dule I	I Listed options & futures	85		
4	Deriv	atives exchanges and derivatives markets	87		
	4.1	Historical development of derivatives exchanges	87		
	4.2	What is a derivatives transaction?	91		
	4.3	Why are derivatives transactions mostly standardized			
		today?	94		
	4.4	What are the functions of derivatives exchanges?	97		
	4.5	Who are the market participants at derivatives			
		exchanges?	98		
	4.6	Which other basic concepts are required for an			
		understanding of derivatives exchanges and derivatives			
		markets?	90		

XVI Contents

	4.7	What is the organizational structure of derivatives exchanges?	103
	4.8	The working of a computerized exchange	
	4.0 4.9		104
	4.10	What is the market maker principle?	100
		Trading at Eurex	107
	4.11	Who regulates derivatives markets?	
	4.12	Which products can be traded?	110
	4.13	The clearing process	110
	4.14	How to specify an order	112
	4.15	What are the expiration dates at Eurex?	117
5	Futur	es – unconditional derivatives contracts	123
	5.1	What are futures?	123
	5.2	Futures markets	124
	5.3	Futures trading	125
	5.4	Basic futures strategies	125
	5.5	Leverage in futures transactions	127
	5.6	Settlement	127
	5.7	Index futures	128
	5.8	Interest rate futures	131
	5.9	Currency futures	133
	5.10	Commodity futures	133
	5.11	Single stock futures	134
	5.12	State of the market in futures trading	135
	5.13	Determination of futures prices	136
	5.14	Pricing of interest rate futures	139
	5.15	What is a CTD bond?	141
	5.16	What is meant by "final settlement?"	142
	5.17	What futures expiration dates exist?	143
	5.18	Which futures strategies exist?	144
		5.18.1 Long futures position	145
		5.18.2 Short futures position	
	5.19	Purchasing a spread	
	5.20	Selling a spread	
	5.21	Inter market spread	149
	5.22	Inter contract spread and intra contract spread	149
	5.23	Cash-and-carry arbitrage	150
	5.24	Arbitrage strategies for money market futures (Euribor).	151
	5.25	Hedges	152
	5.26	Beta-hedging with index futures	153
	5.27	Why futures are used for hedging	155
	5.28	Hedging with interest rate futures	155
			-

Contents XVII

6	Optio	ns – conditional derivatives contracts 16
	6.1	What is an option?
	6.2	Differences in options
	6.3	Option trading
	6.4	What are weekly options?
	6.5	What is a low exercise price option? 168
	6.6	The closing of a derivatives transaction 169
	6.7	What is a rollover?
	6.8	Pricing of options
	6.9	Theories of option pricing
		6.9.1 Intrinsic value
		6.9.2 Time value
	6.10	Early exercise of options
	6.11	Which factors influence the price of an option? 178
		6.11.1 The value of the underlying 178
		6.11.2 Volatility
		6.11.2.1 Historical volatility 179
		6.11.2.2 Implied volatility
		6.11.2.3 The Newton procedure
		6.11.2.4 The influence of volatility 182
		6.11.3 Market interest rates
		6.11.4 Dividend payments
		6.11.5 Term to maturity
		6.11.6 The effect of corporate actions 184
		6.11.6.1 Mergers and acquisitions 185
		6.11.6.2 Extraordinary dividends 185
		6.11.6.3 Cash settlement of corporate actions 185
	6.12	Greeks – sensitivities of option prices
		6.12.1 Delta
		6.12.2 Gamma
		6.12.3 Rho
		6.12.4 Theta
		6.12.5 Vega
		6.12.6 Derivation of Greeks from the Black-Scholes
		formula
	6.13	What is put-call parity?
		6.13.1 Put-call parity relationship 195
		6.13.2 Presentation of the put-call relationship using
		replication
	6.14	Determination of option prices using the Black-Scholes
		model

XVIII Contents

	6.14.1	Assumptions of the Black-Scholes model	198
	6.14.2	The Black-Scholes formula	198
	6.14.3	The Black-Scholes-Merton model	199
	6.14.4	The Black-Scholes differential equation	200
6.15	Determ	ination of option prices using the binomial model	202
	6.15.1	Basic assumptions of the binomial model	202
	6.15.2	Setup of a tree	203
	6.15.3	Implementation of the binomial model	204
6.16	Model	critique	208
6.17	Monte-	Carlo simulation	
6.18	Tradabl	e option prices	212
6.19	Strategi	les using options	212
	6.19.1	What is contained in the four basic strategies	
		in option trading (plain vanilla)?	213
	6.19.2	The strategy LONG CALL	214
	6.19.3	The strategy SHORT CALL	216
	6.19.4	The strategy LONG PUT	219
	6.19.5	The strategy SHORT PUT	220
6.20	How to	hedge with options	222
	6.20.1	Delta hedging	222
	6.20.2	Protective put	223
	6.20.3	Portfolio insurance using calls	224
	6.20.4	Beta hedge	224
6.21	Which	combinations of options are frequently used?	225
	6.21.1	Straddle	225
	6.21.	1.1 Long straddle	225
	6.21.	1.2 Short straddle	226
	6.2	1.1.2.1 Straps	227
	6.2	1.1.2.2 Strips	227
	6.21.2		
	6.21.2	2.1 Long strangle	228
	6.21.2	2.2 Short strangle	228
	6.21.3	Spreads	
6.22	An over	rview of plain vanilla option strategies	233
	6.22.1	Strategies for a positive market outlook	233
	6.22.2	Strategies for a neutral market outlook	233
	6.22.3	Strategies for a negative market outlook	234
	6.22.4	Strategies for a volatile market outlook	234
6.23	Comple	ex option strategies and their implementation :	235
	6.23.1	Butterfly	235
	6.23.2	Condor	237

Contents XIX

		6.23.3 Ratio spread	238
		6.23.3.1 Ratio call spread	238
		6.23.3.2 Ratio put spread	239
			239
		6.23.4.1 Back spread call	239
		6.23.4.2 Back spread put	239
		6.23.5 Box strategies	239
		6.23.5.1 Long box	240
		6.23.5.2 Short box	240
		6.23.6 Time spread or calendar spread	241
		6.23.6.1 Bull calendar spread	241
		6.23.6.2 Bear calendar Spread	242
			242
		6.23.8 Short risk reversal	243
	6.24	How to implement a strategy using options	243
	6.25	Options on futures, synthetic derivatives transactions &	
		combinations	247
		6.25.1 How are options on futures constructed and	
			248
		• • • • • • • • • • • • • • • • • • • •	248
		6.25.3 How to value options on futures with the	
			249
		6.25.4 Which strategies are pursued with options on	
			250
	6.26	•	253
	6.27	Which combinations and linked strategies are used in	
		practice?	254
7	Deriv	vatives on currencies and commodities	261
	7.1	Development of currency trading	261
	7.2	The fundamentals of currency trading	262
	7.3	Economic determinants of exchange rate formation	264
	7.4	Currency spot transactions	264
	7.5	Currency derivatives transactions	264
	7.6	Currency derivatives transactions of banks	265
	7.7	Calculation of the forward rate	266
	7.8	Currency derivatives transactions at exchanges	267
	7.9	Cross rates	267
	7.10	Tobin tax	268
	7.11	What are currency options?	269

7.12	Pricing of a currency option according to		
	Garmar	n-Kohlhagen	
7.13	What a	re currency futures?	
	7.13.1	Pricing of currency futures 271	
	7.13.2	Uses of currency futures	
	7.13.3	Basic intentions of the investor 272	
	7.13.	3.1 Hedging	
	7.13.	3.2 Speculation	
	7.13.	3.3 Speculating on spreads or currency pairs 273	
7.14	Commo	odity derivatives transactions versus commodity	
	spot tra	insactions	
7.15	Commo	odity futures	
	7.15.1	Opening, closing and settlement 275	
	7.15.2	Application of the different settlement	
		possibilities	
	7.15.3	Which commodities serve as underlying for	
		derivatives transactions?	
7.16	Trading	in commodity derivatives 279	
7.17	When s	should investors consider commodity derivatives	
	contrac	ts?	
7.18	Develop	pments and outlook	
7.19	Price de	etermination of commodity derivatives futures 281	
7.20	Prices of	of commodity futures	
7.21	What is	s problematic about contango? 284	
7.22	Futures	trading	
7.23	Storage	285	
7.24	Which	factors can influence pricing? 286	
7.25	Strategi	es in the area of commodity derivatives	
	transact	tions	
	7.25.1	Hedging with commodity derivatives 288	
	7.25.2	Speculating with commodity derivatives 289	
	7.25.3	Arbitrage with commodity derivatives 289	
	7.25.4	Spreads with commodity derivatives 289	
7.26	What a	re combinations between currency and	
		dity derivatives?	
7.27	What st	trategies for currency derivatives exist? 291	
	7.27.1	Hedging strategies 291	
	7.27.2	Speculative strategies	

Contents XXI

Mo	odule III Structured derivatives	297
8	Exotic and non-listed derivatives	299
	8.1 Derivatives that are not exchange traded	299
	8.1.1 OTC derivatives as "flexible options/futures" at	
	Eurex	300
	8.1.2 Caps, floors and collars	301
	8.1.2.1 Caps	301
	8.1.2.2 Caplets	301
	8.1.2.3 Floor	303
	8.1.2.4 Floorlets	303
	8.1.2.5 Valuation of caplets and floorlets	304
	8.1.2.6 Collar	304
	8.1.3 What is a forward?	305
	8.1.4 What is a swap?	306
	8.1.4.1 What are the terms of a swap?	307
	8.1.4.2 Types of swaps and their setup	307
	8.1.4.2.1 Interest rate swap	308
	8.1.4.2.2 Constant Maturity Swap (CMS)	309
	8.1.4.2.3 Currency swap	310
	8.1.4.2.4 Equity index swap	310
	8.1.4.2.5 Forward swap	310
	8.1.4.2.6 Commodity swap	311
	8.1.4.3 Swap trading	312
	8.1.4.4 Valuation of swaps	313
	8.1.4.5 Swaps with variable interest rates	313
	8.1.4.6 Uses of swaps	314
	8.1.4.7 Examples of swaps	314
	8.1.4.7.1 Inflation swaps	
	8.1.4.7.1.1 Inflation payer swap	314
	8.1.4.7.1.1.1 How does the inflation payer	
	swap work?	315
	8.1.4.7.1.1.2 Payment streams of the inflation	
	payer swap	
	8.1.4.7.1.2 Inflation receiver swap	316
	8.1.4.7.1.2.1 How does the inflation receiver	
	swap work?	316
	8.1.4.7.1.2.2 Payment streams of the inflation	
	receiver swap	
	8.1.4.7.2 Express swap EUR/TRY	
	8.1.4.7.3 Second chance swap	322

XXII Contents

		8.1.4.7.4	Callable range accrual swap	325
		8.1.4.7.5	FX linked knockout swap	326
		8.1.4.7.6	Step down swap	328
		8.1.4.8 Sw	ap confirmation	331
		8.1.5 What a	re swaptions and interest rate guarantees?	332
		8.1.5.1 Sw	aptions	332
		8.1.5.2 Rec	ceiver or payer swaption	333
		8.1.5.3 Val	uation of swaptions	334
		8.1.5.4 Set	tlement of a swaption	335
		8.1.6 What a	re exotic options?	336
		8.1.6.1 Wh	at kinds of exotic options do exist?	337
		8.1.6.2 Typ	pes of exotic options	337
		8.1.6.2.1	Barrier options	338
		8.1.6.2.2	Digital options	340
		8.1.6.2.3	Range options	341
		8.1.6.2.4	Bermuda options	342
		8.1.6.2.5	Chooser options	342
		8.1.6.2.6	Compound options	342
		8.1.6.2.7	Window options	342
		8.1.6.2.8	Quanto options	343
		8.1.6.2.9	Rainbow options	344
		8.1.6.2.10	Basket options	345
		8.1.6.2.11	Lookback options	346
		8.1.6.2.12	Cliquet options and ladder options	346
		8.1.6.2.13	Spread options and outperformance	
			options	346
		8.1.6.2.14	Shout options	347
		8.1.6.2.15	Options with delayed premium	
			payment – Boston options	
		8.1.6.2.16	Multifactor options	348
		8.1.6.2.17	Exchange options	348
		8.1.6.2.18	Asian options (average options)	348
9	Credi	t derivatives		357
	9.1		credit derivatives	357
	9.2	What is credit?		357
	9.3		ructures exist?	358
	9.4	<del>-</del>	credit derivatives exist?	361
		· -	ll credit derivatives	361
			credit derivatives	362
	9.5		lit derivatives (CDS)	364

Contents XXIII

	9.6	What are iTraxx® futures at Eurex?	365
	9.7	What are securitized credit derivatives?	
	9.8	Problems in the securitization market following the	
		financial market crisis in 2007	368
	9.9	Complexity of the instruments	369
	9.10	Which problems arose during the financial crisis with	
		respect to credit derivatives?	370
10	Weath	ner derivatives	375
	10.1	Fundamentals of weather derivatives	375
	10.2	Information on the underlying in weather derivatives	376
		10.2.1 Degree day indexes	378
		10.2.2 Heating Degree Days (HDD) & Cooling	
		Degree Days (CDD)	379
		10.2.3 Gradtageszahlenindex (GTZ)	380
	10.3	Structuring of weather derivatives	381
	10.4	Conditional weather derivatives	382
		10.4.1 Hedging with call options	383
		10.4.2 Hedging with put options	386
	10.5	Unconditional weather derivatives: swaps and futures	390
		10.5.1 Example of a swap between an ice cream	
		parlor and a travel agency	390
		10.5.2 Futures on the HDD for a railroad company	393
	10.6	Valuation of weather derivatives	395
	10.7	Reasons for the failure of the Black-Scholes model in	
		pricing weather derivatives	395
	10.8	Burn analysis or burning cost method	396
	10.9	Index Value Simulation Method (IVSM)	398
	10.10	Daily Simulation Method (DSM)	398
	10.11	Trading in weather derivatives	399
		10.11.1 The first weather derivatives transactions	399
		10.11.2 The markets for weather derivatives	399
		10.11.2.1 Chicago Mercantile Exchange (CME)	400
		10.11.2.2 London International Financial Futures and	
		Options Exchange (LIFFE)	400
		10.11.2.3 Deutsche Börse AG	401
		10.11.2.4 Eurex	401
	10.12	The participants in the market for weather derivatives	402
		10.12.1 End user	402
		10.12.2 Trader	
		10.12.3 Market maker	403

XXIV Contents

		10.12.4 Broker	
11	Insur 11.1 11.2	ance derivatives	)9
12	Real 12.1 12.2 12.3 12.4 12.5 12.6	options	.6 .7 .9 .9
Mo	dule I	V Application of derivatives 43	17
13	Struc 13.1 13.2 13.3 13.4 13.5 13.6 13.7	Averaging and pyramiding	19 11 12 14 15 16 17 18
14	Use o	of derivatives in financial engineering and fund gement	57 58 50 50

Contents XXV

		14.3.4	Leveraged products 46	5
		14.3.5	Warrants	6
			Structured financial products with interest rate	_
			options	
		14.3.6.	8-1	
		14.3.6.	8	
		14.3.6.	<b>U</b>	
			.6.3.1 Multi callable bonds 46	
			.6.3.2 Multi putable bonds 46	
		14.3.6.		
		14.3.6.		_
			Highly structured financial products 47	
		14.3.7.		
		14.3.7.		
	14.4		erivatives in fund management 47	3
			Strategies for the use of derivatives in the	
		-	portfolio management of a fund 47	
		14.4.1.		
		14.4.1.	•	
		14.4.1.	ε , ε	
		14.4.1.	1	
		14.4.1.		6
			Why are these strategies used in fund portfolio	
		1	management?	7
15	What	is a hedge	e fund?	3
	15.1	What is t	the aim of a hedge fund? 48	4
	15.2	Use of le	verage	4
	15.3	Legal tra	nsparency	
	15.4	Offshore	companies	-
	15.5		butes of hedge funds 48	5
		15.5.1	Market risks	5
		15.5.2	Address non-payment risk 48	6
		15.5.2.	1 Issuer risk 48	6
		15.5.2.	2 Counterparty risk 48	6
		15.5.2.	3 Credit risk 48	6
		15.5.2.	4 Country risk 48	6
		15.5.3	Liquidity risk 48	7
			Manager risk	7
			Operational risk	7
		15.5.6	Strategic risk	8

XXVI Contents

	15.6	Organizational setup of a hedge fund	488
		15.6.1 Hedge fund company	489
		15.6.2 Hedge fund management company	489
		15.6.3 External service providers	489
		15.6.3.1 Prime broker	489
		15.6.3.2 Custodian bank	490
		15.6.3.3 Fund administration	490
	15.7	Strategies	491
		15.7.1 Convertible bond arbitrage	491
		15.7.2 Short equity	492
		15.7.3 Emerging markets	493
		15.7.4 Market neutral equity	493
		15.7.5 Event driven	493
		15.7.6 Fixed income arbitrage	494
		15.7.7 Global macro	494
		15.7.8 Long/short equity	495
	15.8	Managed futures	495
	15.9	Single hedge fund versus fund of hedge funds	495
	15.10	Hedge funds as golden calf?	497
16	Risk o	controlling and margining	501
	16.1	Basics of risk controlling	501
		16.1.1 MaRisk as the basis for risk controlling	503
		16.1.2 Risk controlling of wealth management clients .	506
		16.1.3 Risk controlling of financial engineering units .	506
	16.2	Unforeseeable market events	507
	16.3	What is margin?	508
	16.4	What is risk based margining?	510
	16.5	Why is the deposit of margin required and how is it	
		calculated?	510
	16.6	Which types of margin exist?	
		16.6.1 Premium margin	511
		16.6.2 Additional margin	511
		16.6.3 Variation margin	513
		16.6.4 Futures spread margin	513
	16.7	Option margins	514
		16.7.1 Long positions	514
		16.7.2 Short positions	514
	16.8	Margin during the time of delivery	516
	16.9	Margin for futures	516
	16.10	Margin for future style options	518

Contents XXVII

16.11	How is the margin calculated for option positions?	519
	Calculating the costs of closing a position	
	How to provide margin	
	Settlement price	
	What is a margin call?	
	Forced liquidation from the perspective of the bank or	
	the broker	522
In closing		527
17 Appen	dix	531
	Typical exam questions and problems	531
	Glossary	546
	Table of standard normal distribution	555
	Rating scales	556
	Bond return and rating in context	557
	Internet addresses	559
	Derivatives exchanges globally and their internet	
	addresses	560
References	S	565
Disclaime	r	569
Index		573