

# Contents

<b>1</b>	<b>Literature Review</b> .....	1
<b>2</b>	<b>The Cheyette Model Class</b> .....	3
2.1	The Heath-Jarrow-Morton Framework.....	3
2.2	Derivation of the Cheyette Model Class .....	7
2.3	Particular Models in the Cheyette Model Class .....	9
2.3.1	Ho-Lee Model .....	10
2.3.2	Hull-White Model.....	10
2.3.3	The Three Factor Exponential Model .....	12
2.4	Remarks on the Cheyette Model Class.....	14
<b>3</b>	<b>Analytical Pricing Formulas</b> .....	17
3.1	Bonds .....	18
3.1.1	Multifactor Cheyette Model .....	18
3.1.2	One-Factor Cheyette Model .....	20
3.1.3	The Three Factor Exponential Model .....	20
3.2	Caplets/Floorlets .....	21
3.2.1	The Three Factor Exponential Model .....	25
3.3	Swaptions.....	26
<b>4</b>	<b>Calibration</b> .....	27
4.1	Literature Review .....	27
4.2	The Calibration Problem.....	28
4.2.1	Formulation.....	28
4.2.2	Constraints.....	29
4.2.3	Characterization of the Optimization Space .....	29
4.2.4	Quality Check .....	33
4.3	Optimization Methods .....	34
4.3.1	Newton Algorithm .....	34
4.3.2	Powell Algorithm .....	35
4.3.3	Downhill Simplex Algorithm.....	36

4.3.4	Simulated Annealing .....	39
4.3.5	Genetic Optimization .....	42
4.4	Numerical Results .....	44
<b>5</b>	<b>Monte Carlo Methods</b> .....	<b>47</b>
5.1	Literature Review .....	47
5.2	Simulations in the Cheyette Model Class .....	48
5.3	Quasi-Monte Carlo Simulation .....	50
5.4	Pricing Bonds and European Options .....	51
5.4.1	Pricing Under the Forward Measure .....	51
5.4.2	Distribution of the State Variables .....	52
5.4.3	Covariance .....	54
5.4.4	Numerical Results .....	56
5.5	Pricing Bermudan Swaptions .....	59
5.5.1	Problem Formulation .....	60
5.5.2	Random Tree Methods .....	61
5.5.3	Numerical Results .....	65
5.6	Snowballs .....	69
5.6.1	Numerical Results .....	70
<b>6</b>	<b>Characteristic Function Method</b> .....	<b>73</b>
6.1	Literature Review .....	74
6.2	Affine Diffusion Setup .....	74
6.2.1	Fundamentals .....	74
6.2.2	Classification of the Cheyette Model Class .....	76
6.3	Characteristic Functions .....	77
6.3.1	Fundamentals .....	77
6.3.2	Characteristic Functions in the Affine Diffusion Setup .....	78
6.3.3	Characteristic Functions in the Cheyette Model Class .....	81
6.4	Pricing with Characteristic Functions .....	90
6.4.1	Fundamentals .....	90
6.4.2	Caplets .....	92
6.4.3	Numerical Results .....	94
6.5	Numerical Analysis .....	97
<b>7</b>	<b>PDE Valuation</b> .....	<b>101</b>
7.1	Literature Review .....	101
7.2	Derivation of the Valuation PDE .....	102
7.2.1	Some Specific Examples .....	105
7.3	Boundary Conditions .....	106
7.3.1	Terminal Condition .....	106
7.3.2	Spatial Domain .....	111
7.4	Remarks on the Valuation PDE .....	112
7.5	Numerical Method for PDE Valuation .....	113
7.5.1	Finite Difference with PSOR .....	114
7.5.2	Sparse Grid Implementation .....	117

7.6	Numerical Results.....	121
7.6.1	Bonds .....	122
7.6.2	Caplets .....	122
7.6.3	European Swaptions .....	126
7.6.4	Bermudan Swaptions .....	128
<b>8</b>	<b>Comparison of Valuation Techniques for Interest Rate Derivatives</b> .....	<b>131</b>
8.1	Plain Vanillas .....	131
8.1.1	Bonds .....	131
8.1.2	Caplets .....	132
8.1.3	European Swaptions .....	135
8.2	Exotics .....	136
8.2.1	Bermudan Swaptions .....	136
8.2.2	Snowballs.....	136
<b>9</b>	<b>Greeks</b> .....	<b>137</b>
9.1	Literature Review .....	137
9.2	Bonds .....	138
9.2.1	Model-Greeks .....	138
9.2.2	Market-Greeks .....	140
9.3	Caplets .....	144
9.3.1	Model-Greeks .....	145
9.3.2	Market-Greeks .....	148
9.3.3	Stability of Greeks .....	150
9.4	Swaptions.....	150
9.4.1	European Swaptions .....	150
9.4.2	Bermudan Swaptions .....	154
<b>10</b>	<b>Conclusion</b> .....	<b>159</b>
<b>A</b>	<b>Additional Calculus in the Class of Cheyette Models</b> .....	<b>163</b>
A.1	Derivation of the Forward Rate.....	163
A.2	The Three Factor Exponential Model .....	167
A.2.1	State Variables.....	167
A.2.2	Caplet Pricing .....	169
A.2.3	Distribution of the State Variables.....	171
A.3	Characteristic Functions .....	174
A.4	Greeks .....	184
A.4.1	Derivatives of $V_{ij}^{(k)}$ .....	184
A.4.2	Derivatives of the Forward Rate .....	185
A.4.3	Derivatives of the Cumulative Normal Distribution Function .....	188
A.5	Remarks on the Model.....	192

<b>B</b>	<b>Mathematical Tools</b> .....	195
	B.1 General Results.....	195
	B.2 The Feynman-Kac Theorem.....	197
<b>C</b>	<b>Market Data</b> .....	199
	<b>References</b> .....	203
	<b>Index</b> .....	207

<http://www.pbookshop.com>