Contents

List of Figures **xv**

List of Tables **xvii**

List of Publications **xix**

1 Introduction **1**

1.1 Black-Scholes model 3

1.2 General aspects of finite difference methods 7

1.2.1 Introduction to theory of grids 7

1.2.2 Finite difference approximation of differential operators . 8

1.2.3 Statement of finite difference problem 11

1.2.4 Some aspects of numerical analysis 12

2 Linear Black-Scholes model for American options **15**

2.1 Front-fixing method for American put option with no dividends . . 17

2.1.1 Qualitative properties of the scheme 20

2.1.2 Numerical examples 25

2.2 Front-fixing method for American call option 29

2.2.1 Qualitative properties of the scheme 31

2.2.2 Numerical examples 38

2.3 New efficient front-fixing method for American option pricing . . 43

2.3.1 Qualitative properties of the scheme 46

2.3.2 Numerical examples 51

3 Front-fixing method for some advanced models **57**
3.1 Nonlinear Black-Scholes models 59
3.1.1 Moving domain transformation 59
3.1.2 Preliminary computational algorithms 62
3.1.3 Explicit Schemes 64
3.1.4 Implicit numerical methods 66
3.1.5 Numerical examples 71
3.2 Regime switching model 78
3.2.1 Multi-variable fixed domain transformation 79
3.2.2 Discretization and numerical schemes construction 81
3.2.3 Von Neumann stability analysis 86
3.2.4 Local truncation error and consistency 88
3.2.5 Numerical examples 89

4 Behavioural modelling of option pricing **97**
4.1 Pricing of American option with rationality parameter 101
4.1.1 Numerical solution with irrational exercise 103
4.1.2 Transformation and explicit finite difference method . . . 106
4.1.3 Properties of intensity function and solution 107
4.1.4 Stability and consistency 112
4.1.5 Numerical examples 113
4.2 Regime switching model with rationality parameter 121
4.2.1 Weighted finite difference scheme for PDE problem . . . 122
4.2.2 Qualitative properties of the scheme 124
4.2.3 Numerical examples 132

5 Valuation of multi-asset options **139**
5.1 Exchange options 141
5.2 Spread options 143
5.2.1 Removing the cross-derivative term 144
5.2.2 Numerical analysis of the method 148
5.2.3 American spread options 151
5.2.4 Numerical examples 152

6 Conclusions **157**

References **159**