

Contents

List of Figures	ix
List of Tables	xi
Preface	xiii
I Introduction and Foundations	1
1 Introduction and Overview	3
1.1 Sources and Notes	7
2 Background	8
2.1 A Historical Perspective of the Information Age	8
2.2 Parallels Between Transportation and Telecommunication Networks	12
2.3 Challenges Facing Decision-Makers	14
2.4 Sources and Notes	15
3 Foundations of Supernetworks	16
3.1 Foundational Networks	16
3.1.1 Transportation Networks	17
3.1.2 Telecommunication Networks	20
3.1.3 Economic and Financial Networks	22
3.1.4 An Aside – Supernetworks in Genetics	22
3.2 Characteristics of Supernetworks	23
3.3 Decision-Making Concepts	25
3.3.1 System-Optimization Versus User-Optimization	27
3.3.1.1 The System-Optimized Problem	27
3.3.1.2 The User-Optimized Problem	30
3.3.1.3 Models with Asymmetric Link Costs	31

3.4 Sources and Notes	37
---------------------------------	----

II Multitiered Networks 39

4 Supply Chain Networks and Electronic Commerce 41

4.1 The Supply Chain Network Model with Electronic Commerce	43
4.1.1 Applications	60
4.1.1.1 An Online Grocer – Tesco	60
4.1.1.2 An Online Book Retailer – Amazon.com	60
4.1.2 An Extension	61
4.2 Qualitative Properties	63
4.3 The Algorithm	68
4.4 Numerical Examples	72
4.5 Sources and Notes	77

5 A Multilevel Perspective for Supply Chain Dynamics 78

5.1 The Dynamic Supply Chain Model	79
5.1.1 An Extension	87
5.1.1.1 An Application to a B2B Exchange – Covisint	87
5.1.1.2 B2B Electronic Commerce and General Electric	89
5.2 Qualitative Properties	90
5.3 The Discrete-Time Adjustment Process	91
5.4 Numerical Examples	96
5.5 Transportation and Telecommunication Network Level	104
5.6 Sources and Notes	105

6 Dynamic Financial Networks with Intermediation 108

6.1 The Dynamic Financial Network Model with Intermediation	109
6.1.1 Charles Schwab & Co., Inc. – An Online Brokerage	122
6.1.2 Experiences with Online Investing Outside the United States	122
6.2 Qualitative Properties	123
6.3 The Discrete-Time Adjustment Process	125
6.4 Numerical Examples	127
6.5 Concluding Remarks	131
6.6 Sources and Notes	132

III Multicriteria Networks 133

7 Multicriteria Network Equilibrium Modeling 135

7.1 The Multiclass, Multicriteria Network Equilibrium Models	138
7.2 Qualitative Properties	145
7.3 Applications	151

7.3.1	Modeling Telecommuting versus Commuting Decision-Making	151
7.3.2	Modeling Teleshopping versus Shopping Decision-Making	153
7.4	The Algorithm	158
7.5	Numerical Examples	161
7.5.1	A Telecommuting versus Commuting Example	161
7.5.2	A Teleshopping versus Shopping Example	166
7.6	Sources and Notes	172
8	A Space-Time Network for Telecommuting versus Commuting	173
8.1	The Model	175
8.1.1	The Teleworking Experience at AT&T	184
8.1.2	The European Experience	184
8.2	Qualitative Properties	186
8.3	Numerical Examples	187
8.4	Sources and Notes	195
9	Urban Location and Transportation in the Information Age	196
9.1	The Multicriteria Network Models of Location and Transportation	197
9.1.1	Some Practical Experiences from Employees and Employers	207
9.1.1.1	Silicon Valley and Congestion	208
9.1.1.2	Kista Science City	208
9.1.2	Location and Internet Congestion	209
9.2	Qualitative Properties	209
9.3	The Algorithm	210
9.4	Numerical Examples	211
9.5	Sources and Notes	224
IV	New Directions	225
10	Supernetworks of Producers and Consumers	227
10.1	The Model with Multicriteria Producers and Consumers	229
10.1.1	Some Experiences from Freight Carriers	236
10.1.1.1	Railroads as Freight Movers in the Information Age	237
10.1.1.2	Trucking and Congestion	237
10.2	Qualitative Properties	238
10.3	The Dynamics	242
10.4	The Discrete-Time Algorithm	244
10.5	Numerical Examples	249
10.6	Sources and Notes	254

11 Multicriteria Decision-Making in Financial Networks	255
11.1 The Bicriteria Portfolio Selection Model	257
11.1.1 The Portfolio Selection Model with Two Objectives	257
11.1.2 Value Functions with Variable Weights	259
11.1.3 The Portfolio Selection Model with Value Functions	261
11.2 Variational Inequality Formulation	264
11.3 Measurement of Financial Risk in the Twenty-first Century	269
11.3.1 Experiences from Asia Economies	270
11.4 Concluding Comments	271
11.5 Sources and Notes	271
12 Paradoxes and Policies	273
12.1 The Network Equilibrium Model with Emissions	274
12.2 Paradoxes on Supernetworks with Zero Emission Links	277
12.3 An Emission Pricing Policy to Circumvent Paradoxes	282
12.4 Multicriteria Decision-Making and Emission Policies	286
12.5 Sources and Notes	287
A Optimization Theory	289
A.1 Karush-Kuhn-Tucker Optimization Conditions	293
A.2 Optimization Examples	296
B Variational Inequalities and Projected Dynamical Systems	298
B.1 Variational Inequalities	298
B.1.1 Qualitative Properties	302
B.2 Projected Dynamical Systems	304
B.2.1 Stability Results	307
C Algorithms	309
C.1 Algorithms for Variational Inequalities	309
C.2 Algorithms for Projected Dynamical Systems	311
C.3 Algorithms for Network Optimization Problems	313
C.3.1 An Equilibration Algorithm for Linear and Separable Link Cost Functions	314
Bibliography	319
Glossary of Notation	341