

Contents

List of Figures	xii
List of Tables	xv
Preface	xvi
I Supply Chain Networks	1
1 Introduction and Overview	3
2 Supply Chain Networks	9
2.1 The Supply Chain Network Model	11
2.1.1 The Behavior of the Manufacturers and their Optimality Conditions	12
2.1.2 The Behavior of the Retailers and their Optimality Conditions	14
2.1.3 The Consumers at the Demand Markets and the Equilibrium Conditions	16
2.1.4 The Equilibrium Conditions of the Supply Chain	18
2.1.5 Some Illustrative Examples	22
2.2 Qualitative Properties	29
2.3 The Algorithm	33
2.4 Computations	36
2.5 Sources and Notes	42
3 Transportation Network Equilibrium Transformations	44
3.1 The Supply Chain Network Equilibrium Model	46
3.2 The Elastic Demand Transportation Network Equilibrium Model	50
3.3 Supernetwork Equivalence of the Supply Chain Network Model	52
3.3.1 Transportation Formulations of Simple Supply Chains	58

3.4	The Algorithm and Numerical Examples	63
3.5	Sources and Notes	69
4	Supply Chains and Risk Management	71
4.1	The Supply Chain Network Model with Risk Management . .	73
4.1.1	The Behavior of the Manufacturers and their Optimality Conditions	73
4.1.2	The Behavior of the Distributors and their Optimality Conditions	77
4.1.3	The Retailers and their Optimality Conditions	79
4.1.4	The Market Equilibrium Conditions	83
4.1.5	The Equilibrium Conditions of the Supply Chain	83
4.2	Qualitative Properties	85
4.3	The Algorithm	92
4.3.1	Numerical Examples	92
4.4	Sources and Notes	97
5	Dynamic Supply Chain Networks and Transportation	98
5.1	The Supply Chain Network Model with Fixed Demands	100
5.1.1	The Behavior of the Manufacturers and their Optimality Conditions	102
5.1.2	The Behavior of the Retailers and their Optimality Conditions	103
5.1.3	The Consumers at the Demand Markets and the Equilibrium Conditions	104
5.1.4	The Equilibrium Conditions of the Supply Chain	105
5.2	The Fixed Demand Transportation Network Model	108
5.3	Transportation Formulation of Fixed Demand Supply Chains	110
5.4	Supply Chain Networks and Time-Varying Demands	114
5.4.1	Evolutionary Variational Inequalities and the Braess Paradox	118
5.5	Solution of Dynamic Supply Chain Network Examples	123
5.6	Sources and Notes	137
II	Energy Supply Chains	139
6	Electric Power Supply Chains	141
6.1	The Supply Chain Model for Electric Power	144
6.1.1	The Behavior of Power Generators and their Optimality Conditions	146
6.1.2	The Behavior of Power Suppliers and their Optimality Conditions	148
6.1.2.1	Transmission Service Providers	149
6.1.3	Equilibrium Conditions for the Demand Markets	151

6.1.4	The Equilibrium Conditions for the Power Supply Chain Network	152
6.1.5	A Simple Electric Power Supply Chain Network Solved Explicitly	156
6.2	Qualitative Properties	158
6.3	Computations	159
6.4	Sources and Notes	166
7	Dynamics Under Risk and Uncertainty	167
7.1	The Dynamic Electric Power Supply Chain Network Model	169
7.1.1	Demand Market Price Dynamics	171
7.1.2	The Dynamics of the Prices at the Power Suppliers	172
7.1.3	Precursors to the Dynamics of the Electric Power Transactions	172
7.1.4	Multicriteria Decision-Making Behavior of the Power Generators	173
7.1.5	Multicriteria Decision-Making Behavior of the Power Suppliers	175
7.1.6	The Dynamics of the Electricity Transactions between Power Generators and Suppliers	179
7.1.7	The Dynamics of the Electricity Transactions between Power Suppliers and Demand Markets	179
7.1.8	The Projected Dynamical System	180
7.1.9	More Theoretical Results	182
7.2	The Euler Method	185
7.3	Numerical Examples	186
7.4	Sources and Notes	197
8	Electric Power Supply Chains and Transportation	199
8.1	The Electric Power Supply Chain Network Models	201
8.1.1	The Behavior of the Power Generators and their Optimality Conditions	203
8.1.2	The Behavior of Power Suppliers and their Optimality Conditions	204
8.1.3	Equilibrium Conditions for the Demand Markets	205
8.1.4	The Equilibrium Conditions for the Electric Power Supply Chain Network	207
8.2	Transportation Network Models with Elastic Demands	210
8.2.1	Transportation Network Equilibrium Model with Demand Functions	210
8.2.2	Transportation Network Equilibrium Model with Disutility Functions	212
8.3	Transportation Network Reformulations for Electric Power	213
8.3.1	Supernetwork Equivalence for Case 1	213
8.3.2	Supernetwork Equivalence for Case 2	218

8.4	Computations	222
8.5	Evolutionary Variational Inequalities and Electric Power . . .	230
8.5.1	A Dynamical Numerical Electric Supply Chain Network Example with Computations	230
8.6	Sources and Notes	236
9	Power Plant Selection and Policy Interventions	238
9.1	The Electric Power Model with Power Plants	239
9.1.1	The Behavior of the Power Generators and their Optimality Conditions	242
9.1.2	The Behavior of Power Suppliers and their Optimality Conditions	244
9.1.3	Equilibrium Conditions for the Demand Markets . . .	245
9.1.4	The Equilibrium Conditions for the Electric Power Supply Chain Network	246
9.2	Transportation Network Equilibrium Reformulation	248
9.3	Computations	254
9.4	Sources and Notes	262
III	Environmental and Financial Networks	265
10	Supply Chains and Environmental Criteria	267
10.1	The Model with Environmental Concerns	269
10.1.1	The Behavior of the Manufacturers	269
10.1.2	The Behavior of the Retailers	273
10.1.3	The Consumers at the Demand Markets	276
10.1.4	The Equilibrium Conditions of the Supply Chain . . .	278
10.2	The Dynamics	281
10.2.1	The Demand Market Price Dynamics	281
10.2.2	The Dynamics of the Product Transactions between the Retailers and the Demand Markets	282
10.2.3	The Dynamics of the Product Transactions between the Manufacturers and the Demand Markets	282
10.2.4	The Dynamics of the Prices at the Retailers	283
10.2.5	The Dynamics of Product Transactions between Manufacturers and Retailers	283
10.2.6	The Projected Dynamical System	284
10.3	The Algorithm	286
10.4	Numerical Examples	288
10.5	Sources and Notes	293

11 Reverse Supply Chain Management and E-Cycling	294
11.1 The E-Cycling Network Model	296
11.1.1 The Behavior of the Sources of the Electronic Waste .	298
11.1.2 The Behavior of the Recyclers and their Optimality Conditions	300
11.1.3 The Behavior of the Processors and their Optimality Conditions	302
11.1.4 The Demand Markets and the Equilibrium Conditions	304
11.1.5 The Equilibrium Conditions of the E-Cycling Network for Reverse Supply Chain Management	305
11.2 Qualitative Properties	308
11.3 The Algorithm	309
11.4 Numerical Examples and Discussion	314
11.5 Sources and Notes	321
12 Financial Networks and Transportation	322
12.1 The Financial Network Model	324
12.1.1 The Behavior of the Source Agents	328
12.1.2 The Behavior of the Financial Intermediaries	329
12.1.3 The Consumers at the Demand Markets and the Equi- librium Conditions	330
12.1.4 The Equilibrium Conditions for the Financial Network with Electronic Transactions	332
12.2 Transportation Reformulation of the Model	336
12.3 Numerical Examples	345
12.4 Sources and Notes	355
A Optimization Theory, VIs, and PDSs	359
A.1 Karush-Kuhn-Tucker Optimization Conditions	363
A.2 Variational Inequalities	366
A.2.1 Qualitative Properties	370
A.3 Projected Dynamical Systems	372
A.3.1 Stability Results	375
B Problems	377
Bibliography	391
Glossary of Notation	407
Index	409