

Contents

1	Introduction	1
1.1	History of Network DEA	2
1.2	Basic Ideas of Efficiency Measurement	3
1.3	Multi-input Case	7
1.4	Multi-output Case	9
1.5	Whole-Unit Analysis	11
1.6	Network Analysis	13
1.7	Supplementary Literature	15
	References	16
2	Output–Input Ratio Efficiency Measures	19
2.1	CCR Model	20
2.1.1	Input Model	20
2.1.2	Output Model	24
2.2	BCC Model	26
2.2.1	Input Model	27
2.2.2	Output Model	30
2.3	Restrictions on Multipliers	33
2.4	Ranking	35
2.5	Supplementary Literature	39
	References	39
3	Distance Function Efficiency Measures	43
3.1	Production Possibility Set	44
3.2	Input Distance Function	47
3.3	Output Distance Function	53
3.4	Directional Distance Function	58
3.5	Supplementary Literature	61
	References	62

4	Slacks-Based Efficiency Measures	65
4.1	Additive Model	66
4.2	Russell Measures	69
4.2.1	Input Model	69
4.2.2	Output Model	72
4.2.3	Input–Output Average Model	74
4.3	Russell Ratio Model	77
4.4	A Classification of Efficiency Measures	81
4.5	Supplementary Literature	85
	References	85
5	Efficiency Measurement in Special Production Stages	89
5.1	Multiplicative Model	90
5.1.1	Variable Returns to Scale	91
5.1.2	Constant Returns to Scale	95
5.2	Free Disposal Hull	98
5.2.1	General Case	98
5.2.2	Constant Returns to Scale	101
5.3	Congestion	103
5.3.1	Weak Disposability Model	104
5.3.2	Slack-Measure Model	105
5.3.3	Input-Fixing Model	107
5.3.4	Comparison	108
5.4	Supplementary Literature	110
	References	111
6	Special Types of Input and Output Factors	113
6.1	Non-discretionary Factors	114
6.1.1	Input Model	114
6.1.2	Output Model	116
6.1.3	Dual Model Interpretation	118
6.1.4	Constant Returns to Scale	119
6.2	Undesirable Factors	121
6.2.1	Input–Output Exchange Approach	121
6.2.2	Data Transformation	122
6.2.3	Weak Disposability Approach	124
6.2.4	Slacks-Based Approach	127
6.3	Supplementary Literature	128
	References	129
7	Special Types of Data	133
7.1	Negative Data	134
7.2	Ordinal Data	136
7.3	Qualitative Data	137
7.4	Stochastic Data	141
7.5	Interval Data	146

7.6	Fuzzy Data	148
7.7	Supplementary Literature	152
	References	153
8	Changes of Efficiency Over Time	157
8.1	Theoretic Foundation of MPI	158
8.1.1	Input Index	158
8.1.2	Output Index	159
8.1.3	Productivity Index	159
8.2	DEA Measurement of MPI	161
8.3	Global Malmquist Productivity Index	166
8.4	Luenberger Productivity Index	169
8.5	Supplementary Literature	173
	References	173
9	Basic Ideas in Efficiency Measurement for Network Systems	177
9.1	The Black-Box Model	179
9.2	Independent Model	181
9.2.1	Multiplier Form	181
9.2.2	Envelopment Form	182
9.2.3	Slacks-Based Form	183
9.3	Connected Model	185
9.3.1	Envelopment Form	185
9.3.2	Multiplier Form	187
9.3.3	Slacks-Based Form	189
9.4	Relational Model	190
9.4.1	Multiplier Form	190
9.4.2	Envelopment Form	192
9.4.3	Slacks-Based Form	193
9.5	An Example	194
9.5.1	Independent Model	195
9.5.2	Connected Model	198
9.5.3	Relational Model	202
9.6	Supplementary Literature	205
	References	205
10	Basic Two-Stage Systems	207
10.1	Independent Model	208
10.2	Ratio-Form Efficiency Measures	211
10.2.1	Efficiency Decomposition	211
10.2.2	Efficiency Aggregation	219
10.3	Distance Function Efficiency Measures	223
10.3.1	System Parameter	223
10.3.2	Division Parameters	227
10.4	Slacks-Based Efficiency Measures	229
10.5	Supplementary Literature	231
	References	233

11	General Two-Stage Systems	237
11.1	Feedback System	238
11.2	Independent Efficiency Measures	243
11.3	Ratio-Form Efficiency Measures	246
11.3.1	Game Approach	246
11.3.2	Efficiency Aggregation	248
11.3.3	Efficiency Decomposition	250
11.4	Distance Function Efficiency Measures	255
11.4.1	System Parameter	255
11.4.2	Division Parameters	258
11.4.3	Directional Distance Parameter	260
11.5	Slacks-Based Efficiency Measures	261
11.6	Shared Input	264
11.7	Supplementary Literature	268
	References	271
12	General Multi-Stage Systems	275
12.1	Basic Series Structure	276
12.1.1	Efficiency Decomposition	276
12.1.2	Efficiency Aggregation	280
12.2	Independent Efficiency Measures	282
12.3	Ratio-Form Efficiency Measures	283
12.3.1	Efficiency Aggregation	283
12.3.2	Efficiency Decomposition	285
12.4	Distance Function Efficiency Measures	289
12.4.1	System Parameter	289
12.4.2	Division Parameters	291
12.5	Slacks-Based Efficiency Measures	295
12.6	Reversal Links	298
12.6.1	Ratio-Form Efficiency Measures	299
12.6.2	Slacks-Based Efficiency Measures	301
12.7	Supplementary Literature	304
	References	306
13	Parallel Systems	309
13.1	Multi-Component Systems	310
13.2	Multi-Function Systems	314
13.3	Shared Input	318
13.3.1	Ratio-Form Efficiency Measures	319
13.3.2	Distance Function Efficiency Measures	322
13.3.3	Slacks-Based Efficiency Measures	327
13.4	Supplementary Literature	330
	References	332

14 Hierarchical Systems	335
14.1 Multi-Component Systems	336
14.2 Multi-Function Systems	342
14.3 General Model	347
14.4 Slacks-based Efficiency Measures	351
14.5 Supplementary Literature	352
References	353
15 Assembly and Disassembly Systems	355
15.1 Assembly Systems	356
15.1.1 The Basic Two-Division Series Structure	356
15.1.2 The Basic Two-Division Parallel Structure	357
15.1.3 The Basic Two-Division Series Structure with Exogenous Inputs	359
15.1.4 The Basic Three-Division (Assembly) Structure	362
15.1.5 The Basic Three-Division Structure with Exogenous Inputs	363
15.1.6 An Example	365
15.1.7 Non-Uniqueness of Decomposition	368
15.2 Disassembly Systems	370
15.2.1 The Basic Two-Division Series Structure	370
15.2.2 The Basic Two-Division Parallel Structure	370
15.2.3 The Basic Two-Division Series Structure with Exogenous Outputs	371
15.2.4 The Basic Three-Division (Disassembly) Structure	372
15.2.5 The Basic Three-Division Structure with Exogenous Outputs	374
15.2.6 An Example	375
15.2.7 Hierarchical Systems	378
15.3 Distance Function Efficiency Measures	381
15.4 Slacks-Based Efficiency Measures	383
15.5 Supplementary Literature	385
References	386
16 Mixed Systems	387
16.1 Independent Efficiency Measures	388
16.2 Ratio-Form Efficiency Measures	391
16.3 Distance Function Efficiency Measures	394
16.4 Slacks-Based Efficiency Measures	396
16.4.1 The Environmental Protection Example	396
16.4.2 The Bank Profit Centers Example	399
16.4.3 The Corporate and Consumer Banking Example	401
16.4.4 The NBA Basketball Example	403
16.5 Supplementary Literature	406
References	407

17	Dynamic Systems	409
17.1	Ratio-Form Efficiency Measures	410
17.1.1	The Whole-Unit Case	410
17.1.2	The Network Case	412
17.2	Distance Function Efficiency Measures	414
17.2.1	The Production Delays Example	415
17.2.2	The Period Distance Parameters Case	416
17.2.3	Directional Distance Function: Whole Unit	417
17.2.4	Directional Distance Function: Network	419
17.3	Slacks-Based Efficiency Measures	420
17.3.1	The Basic Dynamic Structure Case	421
17.3.2	The Aggregate Slack Case	422
17.3.3	The Network Case	424
17.4	Value-Based Efficiency Measures	426
17.5	Supplementary Literature	427
	References	429
18	Epilogue	433
18.1	Generality of Some Representative Models	433
18.2	Which Model to Use	437
18.3	Road Ahead	439
	Index	441

Network Data Envelopment Analysis
Foundations and Extensions

Kao, C.

2017, XV, 443 p. 104 illus., Hardcover

ISBN: 978-3-319-31716-8