

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



<http://www.springer.com/978-3-319-31716-8>

Network Data Envelopment Analysis
Foundations and Extensions

Kao, C.

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

ISBN: 978-3-319-31716-8