
Contents

1	Inventories Are Everywhere	1
1.1	The Roles of Inventory	2
1.2	Fundamental Questions	5
1.3	Factors Affecting Inventory Policy Decisions	6
1.3.1	System Structure	6
1.3.2	The Items	7
1.3.3	Market Characteristics	8
1.3.4	Lead Times	12
1.3.5	Costs	12
1.4	Measuring Performance	15
2	EOQ Model	17
2.1	Model Development: Economic Order Quantity (EOQ) Model	18
2.1.1	Robustness of the EOQ Model	22
2.1.2	Reorder Point and Reorder Interval	25
2.2	EOQ Model with Backordering Allowed	26
2.2.1	The Optimal Cost	31
2.3	Quantity Discount Model	31
2.3.1	All Units Discount	33
2.3.2	An Algorithm to Determine the Optimal Order Quantity for the All Units Discount Case	35
2.3.3	Incremental Quantity Discounts	36
2.3.4	An Algorithm to Determine the Optimal Order Quantity for the Incremental Quantity Discount Case	38
2.4	Lot Sizing When Constraints Exist	40
2.5	Exercises	42

3	Power-of-Two Policies	47
3.1	Basic Framework	48
3.1.1	Power-of-Two Policies	49
3.1.2	PO2 Policy for a Single-Stage System	51
3.1.2.1	Cost for the Optimal PO2 Policy	53
3.2	Serial Systems	55
3.2.1	Assumptions and Nomenclature	55
3.2.2	A Mathematical Model for Serial Systems	59
3.2.3	Algorithm to Obtain an Optimal Solution to (<i>RP</i>)	64
3.3	Multi-Echelon Distribution Systems	68
3.3.1	A Mathematical Model for Distribution Systems	68
3.3.1.1	Relaxed Problem	69
3.3.2	Powers-of-Two Solution	73
3.4	Joint Replenishment Problem (JRP)	74
3.4.1	A Mathematical Model for Joint Replenishment Systems	75
3.4.2	Rounding the Solution to the Relaxed Problem	80
3.5	Exercises	82
4	Dynamic Lot Sizing with Deterministic Demand	85
4.1	The Wagner–Whitin (WW) Algorithm	86
4.1.1	Solution Approach	89
4.1.2	Algorithm	92
4.1.3	Shortest-Path Representation of the Dynamic Lot Sizing Problem	94
4.1.4	Technical Appendix for the Wagner–Whitin Algorithm	95
4.2	Wagelmans–Hoesel–Kolen (WHK) Algorithm	96
4.2.1	Model Formulation	97
4.2.2	An Order $T \log T$ Algorithm for Solving Problem (4.5)	98
4.2.3	Algorithm	102
4.3	Heuristic Methods	104
4.3.1	Silver–Meal Heuristic	104
4.3.2	Least Unit Cost Heuristic	106
4.4	A Comment on the Planning Horizon	108
4.5	Exercises	109
5	Single-Period Models	113
5.1	Making Decisions in the Presence of Uncertainty	114
5.2	An Example	114
5.2.1	The Data	115
5.2.2	The Decision Model	117

5.3	Another Example	124
5.4	Multiple Items	127
5.4.1	A General Model	132
5.4.2	Multiple Constraints	135
5.5	Exercises	136
6	Inventory Planning over Multiple Time Periods: Linear-Cost Case	141
6.1	Optimal Policies	141
6.1.1	The Single-Unit, Single-Customer Approach: Single-Location Case	142
6.1.1.1	Notation and Definitions	142
6.1.1.2	Optimality of Base-Stock Policies	145
6.1.1.3	Stochastic Lead Times	149
6.1.1.4	The Serial Systems Case	149
6.1.1.5	Generalized Demand Model	150
6.1.1.6	Capacity Limitations	151
6.2	Finding Optimal Stock Levels	151
6.2.1	Finite Planning Horizon Analysis	151
6.2.2	Constant, Positive Lead Time Case	159
6.2.3	End-of-Horizon Effects	160
6.2.4	Infinite-Horizon Analysis	161
6.2.5	Lost Sales	162
6.3	Capacity Limited Systems	163
6.3.1	The Shortfall Distribution	164
6.3.1.1	General Properties	164
6.3.2	Discrete Demand Case	166
6.3.3	An Example	171
6.4	A Serial System	173
6.4.1	An Echelon-Based Approach for Managing Inventories in Serial Systems	174
6.4.1.1	A Decision Model	175
6.4.1.2	A Dynamic Programming Formulation of the Decision Problem	176
6.4.1.3	An Algorithm for Computing Optimal Echelon Stock Levels	180
6.4.1.4	Solving the Oil Rig Problem: The Stationary Demand Case	180
6.5	Exercises	181

7	Background Concepts: An Introduction to the $(s - 1, s)$ Policy under Poisson Demand	185
7.1	Steady State	186
7.1.1	Backorder Case	188
7.1.2	Lost Sales Case	190
7.2	Performance Measures	193
7.3	Properties of the Performance Measures	198
7.4	Finding Stock Levels in $(s - 1, s)$ Policy Managed Systems: Optimization Problem Formulations and Solution Algorithms	202
7.4.1	First Example: Minimize Expected Backorders Subject to an Inventory Investment Constraint	202
7.4.2	Second Example: Maximize Expected System Average Fill Rate Subject to an Inventory Investment Constraint	206
7.5	Exercises	208
8	A Tactical Planning Model for Managing Recoverable Items in Multi-Echelon Systems	211
8.1	The METRIC System	212
8.1.1	System Operation and Definitions	213
8.1.2	The Optimization Problem	213
8.1.2.1	Approximating the Stationary Probability Distribution for the Number of LRUs in Resupply	217
8.1.2.2	Finding Depot and Base LRU Stock Levels	221
8.2	Waiting Time Analysis	230
8.3	Exercises	234
9	Reorder Point, Lot Size Models: The Continuous Review Case	237
9.1	An Approximate Model When Backordering Is Permitted	239
9.1.1	Assumptions	239
9.1.2	Constructing the Model	240
9.1.3	Finding Q^* and r^*	242
9.1.4	Convexity of the Objective Function	244
9.1.5	Lead Time Demand Is Normally Distributed	246
9.1.6	Alternative Heuristics for Computing Lot Sizes and Reorder Points	248
9.1.7	Final Comments on the Approximate Model	253
9.2	An Exact Model	253
9.2.1	Determining the Stationary Distribution of the Inventory Position Random Variable	254

9.2.2	Determining the Stationary Distribution of the Net Inventory Random Variable	255
9.2.3	Computing Performance Measures	256
9.2.4	Average Annual Cost Expression	258
9.2.5	Waiting Time Analysis	258
9.2.6	Continuous Approximations: The General Case	260
9.2.7	A Continuous Approximation: Normal Distribution	262
9.2.8	Another Continuous Approximation: Laplace Distribution	264
9.2.9	Optimization	266
9.2.9.1	Normal Demand Model	267
9.2.9.2	Laplace Demand Model	270
9.2.9.3	Exact Poisson Model	271
9.2.10	Additional Observations: Compound Poisson Demand Process, Uncertain Lead Times	273
9.2.10.1	Finding the Stationary Distribution of the Inventory Position Random Variable When an (nQ, r) Policy Is Followed	275
9.2.10.2	Establishing the Probability Distribution of the Inventory Position Random Variable When an (s, S) Policy Is Employed	276
9.2.10.3	Constructing an Objective Function	278
9.2.11	Stochastic Lead Times	280
9.3	A Multi-Item Model	282
9.3.1	Model 1	283
9.3.2	Model 2	285
9.3.3	Model 3	285
9.3.4	Model 4	286
9.3.5	Finding Q_i	287
9.4	Exercises	287
10	Lot Sizing Models: The Periodic Review Case	293
10.1	Notation	294
10.2	An Approximation Algorithm	296
10.2.1	Algorithm	296
10.3	Algorithm for Computing a Stationary Policy	301
10.3.1	A Primer on Dynamic Programming with an Average Cost Criterion	302
10.3.2	Formulation and Background Results	302
10.3.3	Algorithm	307
10.4	Proof of Theorem 10.1	310

10.5 A Heuristic Method for Calculating s and S	314
10.6 Exercises	316
References	319
Index	337

<http://www.springer.com/978-0-387-24492-1>

Principles of Inventory Management
When You Are Down to Four, Order More
Muckstadt, J.A.; Sapro, A.
2010, XVIII, 339 p., Hardcover
ISBN: 978-0-387-24492-1