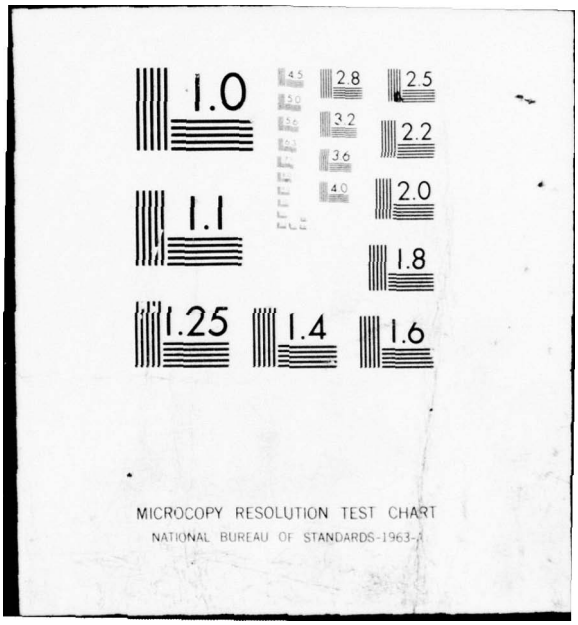
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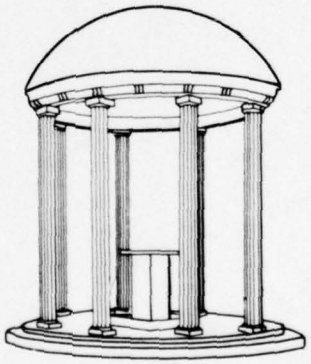

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(s,S) INVENTORY POLICIES IN A NONSTATIONARY DEMAND ENVIRONMENT

Technical Report #11
Appendices

Ronald Kaufman*

April 1977

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Inventory Control; Stockage Policies; Multi-item Replenishment Systems; (s,S) Policies; Computer Systems Simulation; Retrospective Simulation; Nonstationary Demands; Approximately optimal policies.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Scarf (1960) proves the optimality of (s,S) policies for a class of discrete review nonstationary inventory models. A considerable amount of inventory literature concerns computation of optimal and approximately optimal (s,S) policies under the Scarf hypotheses. Little research has dealt, however, with the case of nonstationary demands. This investigation examines the situation in which demand distributions are independent, but not identically distributed, and vary in a cyclic manner. Products that experience seasonal demands are a typical example of such a demand process.

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A detailed analysis of the nature of optimal policies in the non-stationary environment is presented. The behavior of selected operating characteristics such as period-end inventory, backlogged demand, frequency of stockout, replenishment frequency, and associated costs also are examined. The above performance measures for an individual inventoried good are aggregated over all goods to provide an analysis of the multi-item system behavior.

Approximately optimal (s,S) policies are derived for the nonstationary environment. The policies are based on the power approximation of Ehrhardt (1976), and require knowledge of only the mean and variance of demand. The operating characteristics of approximately optimal policies are compared with those of optimal policies.

The approximately optimal policy rule is examined in a statistical environment that generalizes MacCormick (1974). Policy parameters are revised periodically using a limited history of past demands to estimate the mean and variance of demand. Each time the policy parameters are revised, forecasts of system operating characteristics are calculated from a retrospective simulation employing the same sample of demands that was used to revise the policy.

The statistical phenomena are studied by means of a computer simulation program using time series analysis techniques.

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Appendix A

Single-item Data

Stationary Model

Summary of Data for 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with:

Optimal Policies (DP)

Power Approximation (PA)

Statistical Power Approximation

		page
Table A1	Average Total Cost	A1
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Note: For corresponding data in MacCormick (1974), see tables of the same number in Appendices A of those reports.

TABLE A1 AVERAGE TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

VALUES FOR RULES OTHER THAN THE OPTIMAL DP ARE % EXCESS OVER DP VALUE

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	25.6	0.1	3.5
4	8	4	32	28.3	0.4	5.5
2	16	4	32	35.9	0.1	2.8
4	16	4	32	39.7	0.1	4.7
2	8	99	32	42.1	0.1	9.2
4	8	99	32	48.0	0.1	12.7
2	16	99	32	57.8	0.3	8.5
4	16	99	32	66.1	0.2	11.5
2	8	4	64	32.8	0.2	2.4
4	8	4	64	35.2	0.3	4.2
2	16	4	64	46.3	0.2	2.2
4	16	4	64	49.6	0.2	4.0
2	8	99	64	50.0	0.1	6.9
4	8	99	64	55.8	0.0	9.7
2	16	99	64	69.3	0.0	6.5
4	16	99	64	77.2	0.1	9.4

TABLE A3 PERIOD-END INVENTORY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	11.5	11.1	11.5
4	8	4	32	13.8	12.4	13.9
2	16	4	32	15.9	16.2	16.9
4	16	4	32	18.8	18.3	20.1
2	8	99	32	28.2	28.7	30.1
4	8	99	32	33.7	34.7	36.7
2	16	99	32	37.9	40.5	41.7
4	16	99	32	46.0	48.0	50.4
2	8	4	64	13.8	12.9	13.4
4	8	4	64	16.0	14.3	15.5
2	16	4	64	19.7	18.3	19.6
4	16	4	64	22.1	20.7	22.5
2	8	99	64	31.8	31.3	33.0
4	8	99	64	36.3	37.3	38.9
2	16	99	64	43.1	44.1	45.3
4	16	99	64	50.6	51.1	53.3

TABLE A4 PERIOD-END BACKLOG AS PROPORTION OF MEAN DEMAND

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1716	0.1775	0.1826
4	8	4	32	0.2022	0.2225	0.2244
2	16	4	32	0.1224	0.1129	0.1160
4	16	4	32	0.1482	0.1454	0.1452
2	8	99	32	0.0060	0.0058	0.0086
4	8	99	32	0.0069	0.0058	0.0110
2	16	99	32	0.0041	0.0032	0.0053
4	16	99	32	0.0046	0.0038	0.0071
2	8	4	64	0.1944	0.2047	0.2124
4	8	4	64	0.2184	0.2559	0.2512
2	16	4	64	0.1342	0.1417	0.1347
4	16	4	64	0.1577	0.1661	0.1653
2	8	99	64	0.0056	0.0067	0.0090
4	8	99	64	0.0075	0.0072	0.0117
2	16	99	64	0.0041	0.0040	0.0060
4	16	99	64	0.0046	0.0049	0.0081

TABLE A5 FREQUENCY OF PERIODS WITH BACKLOG

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1859	0.1922	0.1929
4	8	4	32	0.1842	0.2023	0.1960
2	16	4	32	0.1951	0.1839	0.1838
4	16	4	32	0.1967	0.1962	0.1888
2	8	99	32	0.0093	0.0090	0.0123
4	8	99	32	0.0092	0.0078	0.0132
2	16	99	32	0.0100	0.0079	0.0119
4	16	99	32	0.0096	0.0081	0.0131
2	8	4	64	0.1938	0.2040	0.2058
4	8	4	64	0.1863	0.2131	0.2039
2	16	4	64	0.1955	0.2064	0.1950
4	16	4	64	0.1951	0.2055	0.1975
2	8	99	64	0.0086	0.0101	0.0127
4	8	99	64	0.0098	0.0093	0.0138
2	16	99	64	0.0098	0.0095	0.0130
4	16	99	64	0.0094	0.0100	0.0145

TABLE A6 REPLENISHMENT FREQUENCY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.267	0.276	0.283
4	8	4	32	0.250	0.276	0.275
2	16	4	32	0.381	0.390	0.394
4	16	4	32	0.356	0.381	0.380
2	8	99	32	0.286	0.276	0.282
4	8	99	32	0.276	0.276	0.274
2	16	99	32	0.421	0.390	0.392
4	16	99	32	0.400	0.381	0.379
2	8	4	64	0.200	0.211	0.210
4	8	4	64	0.191	0.200	0.205
2	16	4	64	0.281	0.296	0.299
4	16	4	64	0.271	0.286	0.289
2	8	99	64	0.216	0.211	0.209
4	8	99	64	0.211	0.200	0.203
2	16	99	64	0.308	0.296	0.297
4	16	99	64	0.302	0.286	0.287

TABLE A7 ESTIMATED BIAS OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)
COLUMN (1) % EXCESS OF MEAN ACTUAL COST OVER MEAN FORECAST COST
COLUMN (2) + : BIAS FOR O.C.: POSITIVE ; - : NEGATIVE ; # : SIGNIFICANTLY POSITIVE ; = : SIGNIFICANTLY NEGATIVE
SUBCOLUMNS: PERIOD-END INVENTORY, STOCKOUT QUANTITY, STOCKOUT FREQUENCY, REPLENISHMENT QUANTITY, REPLENISHMENT FREQUENCY, COST

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	(1) (24,24,24)	(2) (24,24,24)
2	8	4	32	1.2	# # + + + #
4	8	4	32	2.1	# # + - + #
2	16	4	32	1.5	# + - - + #
4	16	4	32	3.2	# # + + - #
2	8	99	32	5.4	+ # # + + #
4	8	99	32	8.2	# # # + + #
2	16	99	32	5.9	# # # - - #
4	16	99	32	10.4	# # # + - #
2	8	4	64	0.8	# + + + + #
4	8	4	64	2.0	# + - + + #
2	16	4	64	1.4	# + + + + #
4	16	4	64	3.0	# # + + + #
2	8	99	64	4.0	+ # # + + #
4	8	99	64	8.5	# # # + + #
2	16	99	64	5.6	+ # # - + #
4	16	99	64	10.4	+ # # + - #

TABLE A8 ESTIMATED STANDARD DEVIATION OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)

LEADTIME	MEAN	C(OUT)/C(IN)	C(FIX)/C(IN)	(24,24,24)
2	8	4	32	3.4
4	8	4	32	5.0
2	16	4	32	4.0
4	16	4	32	6.0
2	8	99	32	8.3
4	8	99	32	9.4
2	16	99	32	11.0
4	16	99	32	13.6
2	8	4	64	3.7
4	8	4	64	5.3
2	16	4	64	4.1
4	16	4	64	6.0
2	8	99	64	12.1
4	8	99	64	10.0
2	16	99	64	14.6
4	16	99	64	13.1

TABLE A9 VALUES FOR LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	20	20	20	20	20	20	20	20	20	20	20	20
8	4	32	PA	20	20	20	20	20	20	20	20	20	20	20	20
			(24,24)	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
			DP	17	17	17	17	17	17	17	17	17	17	17	17
8	4	64	PA	17	17	17	17	17	17	17	17	17	17	17	17
			(24,24)	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1
			DP	39	39	39	39	39	39	39	39	39	39	39	39
8	99	32	PA	39	39	39	39	39	39	39	39	39	39	39	39
			(24,24)	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4
			DP	38	38	38	38	38	38	38	38	38	38	38	38
8	99	64	PA	37	37	37	37	37	37	37	37	37	37	37	37
			(24,24)	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2	38.2
			DP	42	42	42	42	42	42	42	42	42	42	42	42
16	4	32	PA	43	43	43	43	43	43	43	43	43	43	43	43
			(24,24)	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5
			DP	38	38	38	38	38	38	38	38	38	38	38	38
16	4	64	PA	38	38	38	38	38	38	38	38	38	38	38	38
			(24,24)	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2	39.2
			DP	68	68	68	68	68	68	68	68	68	68	68	68
16	99	32	PA	69	69	69	69	69	69	69	69	69	69	69	69
			(24,24)	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1
			DP	66	66	66	66	66	66	66	66	66	66	66	66
16	99	64	PA	66	66	66	66	66	66	66	66	66	66	66	66
			(24,24)	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISIRIBUTION FOR DEMAND, STATIONARY MODEL
REPLENISHMENT LEADTIMX = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	44	44	44	44	44	44	44	44	44	44	44	44
8	4	32	PA	43	43	43	43	43	43	43	43	43	43	43	43
			(24,24)	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2	43.2
			DP	51	51	51	51	51	51	51	51	51	51	51	51
8	4	64	PA	49	49	49	49	49	49	49	49	49	49	49	49
			(24,24)	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6
			DP	61	61	61	61	61	61	61	61	61	61	61	61
8	99	32	PA	62	62	62	62	62	62	62	62	62	62	62	62
			(24,24)	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1
			DP	69	69	69	69	69	69	69	69	69	69	69	69
8	99	64	PA	69	69	69	69	69	69	69	69	69	69	69	69
			(24,24)	70.7	70.7	70.7	70.7	70.7	70.7	70.7	70.7	70.7	70.7	70.7	70.7
			DP	74	74	74	74	74	74	74	74	74	74	74	74
16	4	32	PA	74	74	74	74	74	74	74	74	74	74	74	74
			(24,24)	74.5	74.5	74.5	74.5	74.5	74.5	74.5	74.5	74.5	74.5	74.5	74.5
			DP	85	85	85	85	85	85	85	85	85	85	85	85
16	4	64	PA	82	82	82	82	82	82	82	82	82	82	82	82
			(24,24)	83.4	83.4	83.4	83.4	83.4	83.4	83.4	83.4	83.4	83.4	83.4	83.4
			DP	96	96	96	96	96	96	96	96	96	96	96	96
16	99	32	PA	100	100	100	100	100	100	100	100	100	100	100	100
			(24,24)	101.1	101.1	101.1	101.1	101.1	101.1	101.1	101.1	101.1	101.1	101.1	101.1
			DP	108	108	108	108	108	108	108	108	108	108	108	108
16	99	64	PA	110	110	110	110	110	110	110	110	110	110	110	110
			(24,24)	111.2	111.2	111.2	111.2	111.2	111.2	111.2	111.2	111.2	111.2	111.2	111.2

TABLE A9 VALUES FOR BIG S - LITTLE S

EGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL
EPLENISHMENT LEADTIME = 2

TATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

AN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	24	24	24	24	24	24	24	24	24	24	24	24
8	4	32	PA	23	23	23	23	23	23	23	23	23	23	23	23
			(24,24)	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7
			DP	34	34	34	34	34	34	34	34	34	34	34	34
8	4	64	PA	32	32	32	32	32	32	32	32	32	32	32	32
			(24,24)	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5
			DP	22	22	22	22	22	22	22	22	22	22	22	22
8	99	32	PA	23	23	23	23	23	23	23	23	23	23	23	23
			(24,24)	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7
			DP	31	31	31	31	31	31	31	31	31	31	31	31
8	99	64	PA	32	32	32	32	32	32	32	32	32	32	32	32
			(24,24)	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5
			DP	32	32	32	32	32	32	32	32	32	32	32	32
6	4	32	PA	31	31	31	31	31	31	31	31	31	31	31	31
			(24,24)	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
			DP	47	47	47	47	47	47	47	47	47	47	47	47
6	4	64	PA	44	44	44	44	44	44	44	44	44	44	44	44
			(24,24)	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2
			DP	28	28	28	28	28	28	28	28	28	28	28	28
6	99	32	PA	31	31	31	31	31	31	31	31	31	31	31	31
			(24,24)	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0	31.0
			DP	42	42	42	42	42	42	42	42	42	42	42	42
6	99	64	PA	44	44	44	44	44	44	44	44	44	44	44	44
			(24,24)	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2

TABLE A9 VALUES FOR LITTLE S

EGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL
EPLENISHMENT LEADTIME = 4

TATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

EAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	37	37	37	37	37	37	37	37	37	37	37	37
8	4	32	PA	37	37	37	37	37	37	37	37	37	37	37	37
			(24,24)	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
			DP	34	34	34	34	34	34	34	34	34	34	34	34
8	4	64	PA	33	33	33	33	33	33	33	33	33	33	33	33
			(24,24)	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1
			DP	60	60	60	60	60	60	60	60	60	60	60	60
8	99	32	PA	61	61	61	61	61	61	61	61	61	61	61	61
			(24,24)	62.3	62.3	62.3	62.3	62.3	62.3	62.3	62.3	62.3	62.3	62.3	62.3
			DP	58	58	58	58	58	58	58	58	58	58	58	58
8	99	64	PA	58	58	58	58	58	58	58	58	58	58	58	58
			(24,24)	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3
			DP	75	75	75	75	75	75	75	75	75	75	75	75
6	4	32	PA	76	76	76	76	76	76	76	76	76	76	76	76
			(24,24)	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5
			DP	71	71	71	71	71	71	71	71	71	71	71	71
6	4	64	PA	71	71	71	71	71	71	71	71	71	71	71	71
			(24,24)	72.6	72.6	72.6	72.6	72.6	72.6	72.6	72.6	72.6	72.6	72.6	72.6
			DP	107	107	107	107	107	107	107	107	107	107	107	107
16	99	32	PA	108	108	108	108	108	108	108	108	108	108	108	108
			(24,24)	109.9	109.9	109.9	109.9	109.9	109.9	109.9	109.9	109.9	109.9	109.9	109.9
			DP	105	105	105	105	105	105	105	105	105	105	105	105
16	99	64	PA	104	104	104	104	104	104	104	104	104	104	104	104
			(24,24)	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	63	63	63	63	63	63	63	63	63	63	63	63
8	4	32	PA	60	60	60	60	60	60	60	60	60	60	60	60
			(24,24)	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5
			DP	70	70	70	70	70	70	70	70	70	70	70	70
8	4	64	PA	67	67	67	67	67	67	67	67	67	67	67	67
			(24,24)	67.9	67.9	67.9	67.9	67.9	67.9	67.9	67.9	67.9	67.9	67.9	67.9
			DP	83	83	83	83	83	83	83	83	83	83	83	83
8	99	32	PA	84	84	84	84	84	84	84	84	84	84	84	84
			(24,24)	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9
			DP	90	90	90	90	90	90	90	90	90	90	90	90
8	99	64	PA	92	92	92	92	92	92	92	92	92	92	92	92
			(24,24)	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0
			DP	110	110	110	110	110	110	110	110	110	110	110	110
16	4	32	PA	108	108	108	108	108	108	108	108	108	108	108	108
			(24,24)	109.7	109.7	109.7	109.7	109.7	109.7	109.7	109.7	109.7	109.7	109.7	109.7
			DP	120	120	120	120	120	120	120	120	120	120	120	120
16	4	64	PA	117	117	117	117	117	117	117	117	117	117	117	117
			(24,24)	118.4	118.4	118.4	118.4	118.4	118.4	118.4	118.4	118.4	118.4	118.4	118.4
			DP	137	137	137	137	137	137	137	137	137	137	137	137
16	99	32	PA	140	140	140	140	140	140	140	140	140	140	140	140
			(24,24)	142.0	142.0	142.0	142.0	142.0	142.0	142.0	142.0	142.0	142.0	142.0	142.0
			DP	148	148	148	148	148	148	148	148	148	148	148	148
16	99	64	PA	150	150	150	150	150	150	150	150	150	150	150	150
			(24,24)	151.8	151.8	151.8	151.8	151.8	151.8	151.8	151.8	151.8	151.8	151.8	151.8

TABLE A9 VALUES FOR BIG S - LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	26	26	26	26	26	26	26	26	26	26	26	26
8	4	32	PA	23	23	23	23	23	23	23	23	23	23	23	23
			(24,24)	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6
			DP	36	36	36	36	36	36	36	36	36	36	36	36
8	4	64	PA	34	34	34	34	34	34	34	34	34	34	34	34
			(24,24)	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7
			DP	23	23	23	23	23	23	23	23	23	23	23	23
8	99	32	PA	23	23	23	23	23	23	23	23	23	23	23	23
			(24,24)	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6	23.6
			DP	32	32	32	32	32	32	32	32	32	32	32	32
8	99	64	PA	34	34	34	34	34	34	34	34	34	34	34	34
			(24,24)	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7
			DP	35	35	35	35	35	35	35	35	35	35	35	35
16	4	32	PA	32	32	32	32	32	32	32	32	32	32	32	32
			(24,24)	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2
			DP	49	49	49	49	49	49	49	49	49	49	49	49
16	4	64	PA	46	46	46	46	46	46	46	46	46	46	46	46
			(24,24)	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9
			DP	30	30	30	30	30	30	30	30	30	30	30	30
16	99	32	PA	32	32	32	32	32	32	32	32	32	32	32	32
			(24,24)	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2
			DP	43	43	43	43	43	43	43	43	43	43	43	43
16	99	64	PA	46	46	46	46	46	46	46	46	46	46	46	46
			(24,24)	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9

TABLE A10 STANDARD DEVIATION OF LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL
STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
4	8	4	32	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
2	8	4	64	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
4	8	4	64	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
2	8	99	32	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
4	8	99	32	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
2	8	99	64	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
4	8	99	64	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
2	16	4	32	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
4	16	4	32	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
2	16	4	64	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
4	16	4	64	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2	16	99	32	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
4	16	99	32	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
2	16	99	64	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
4	16	99	64	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5

TABLE A10 STANDARD DEVIATION OF BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, STATIONARY MODEL
STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(CUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
4	8	4	32	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
2	8	4	64	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
4	8	4	64	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
2	8	99	32	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
4	8	99	32	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
2	8	99	64	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
4	8	99	64	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
2	16	4	32	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
4	16	4	32	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
2	16	4	64	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
4	16	4	64	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
2	16	99	32	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
4	16	99	32	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
2	16	99	64	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
4	16	99	64	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7

Appendix B

Single-item Data

Model I

Summary of Data for 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with:

Optimal Policies (DP)

Power Approximation (PA)

Statistical Power Approximation

		page
Table A1	Average Total Cost	B1
A3	Period-End Inventory	B2
A4	Period-End Backlog as Proportion of Mean Demand	B3
A5	Frequency of Periods with Backlog	B4
A6	Replenishment Frequency	B5
A7	Estimated Bias of Forecast of Total Cost	B6
A8	Estimated Standard Deviation of Forecast of Total Cost	B7
A9	Values for (s_i, S_i)	B8 to B13
A10	Standard Deviations of (s_i, S_i) Values	B14 to B15

Note: For corresponding data in MacCormick (1974), see tables of the same number in Appendices A of those reports.

TABLE A1 AVERAGE TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

VALUES FOR RULES OTHER THAN THE OPTIMAL DP ARE % EXCESS OVER DP VALUE

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	25.3	1.1	4.3
4	8	4	32	28.0	0.9	6.7
2	16	4	32	35.2	1.1	3.9
4	16	4	32	39.1	0.9	6.0
2	8	99	32	41.5	1.4	10.4
4	8	99	32	47.4	1.1	13.8
2	16	99	32	56.6	1.9	10.3
4	16	99	32	65.0	1.2	12.6
2	8	4	64	32.2	1.8	4.5
4	8	4	64	34.6	1.8	5.8
2	16	4	64	45.6	1.0	3.5
4	16	4	64	48.9	1.1	4.4
2	8	99	64	49.0	2.2	10.4
4	8	99	64	54.8	1.6	11.7
2	16	99	64	67.8	1.6	8.6
4	16	99	64	75.9	1.2	10.3

TABLE A3 PERIOD-END INVENTORY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	11.5	10.8	11.8
4	8	4	32	13.4	12.8	14.3
2	16	4	32	16.0	16.5	16.7
4	16	4	32	18.8	18.7	20.5
2	8	99	32	27.7	29.3	31.5
4	8	99	32	33.2	35.2	37.3
2	16	99	32	37.7	40.3	41.6
4	16	99	32	45.5	47.7	50.8
2	8	4	64	13.9	13.1	14.0
4	8	4	64	15.8	14.6	15.8
2	16	4	64	19.2	19.3	20.1
4	16	4	64	21.7	21.1	23.0
2	8	99	64	31.3	32.3	34.1
4	8	99	64	36.7	37.3	39.6
2	16	99	64	41.5	44.9	46.9
4	16	99	64	49.1	51.4	54.5

TABLE A4 PERIOD-END BACKLOG AS PROPORTION OF MEAN DEMAND

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1750	0.1834	0.1784
4	8	4	32	0.2088	0.2148	0.2162
2	16	4	32	0.1177	0.1094	0.1163
4	16	4	32	0.1409	0.1391	0.1421
2	8	99	32	0.0058	0.0051	0.0072
4	8	99	32	0.0068	0.0055	0.0105
2	16	99	32	0.0036	0.0035	0.0054
4	16	99	32	0.0044	0.0040	0.0068
2	8	4	64	0.1866	0.2072	0.2013
4	8	4	64	0.2247	0.2395	0.2435
2	16	4	64	0.1281	0.1261	0.1295
4	16	4	64	0.1542	0.1568	0.1541
2	8	99	64	0.0058	0.0061	0.0089
4	8	99	64	0.0069	0.0071	0.0112
2	16	99	64	0.0038	0.0035	0.0052
4	16	99	64	0.0045	0.0046	0.0070

TABLE A5 FREQUENCY OF PERIODS WITH BACKLOG

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1901	0.1987	0.1894
4	8	4	32	0.1908	0.1964	0.1899
2	16	4	32	0.1926	0.1796	0.1848
4	16	4	32	0.1919	0.1891	0.1848
2	8	99	32	0.0091	0.0081	0.0105
4	8	99	32	0.0092	0.0074	0.0127
2	16	99	32	0.0092	0.0086	0.0121
4	16	99	32	0.0094	0.0086	0.0127
2	8	4	64	0.1904	0.2059	0.1965
4	8	4	64	0.1921	0.2027	0.1988
2	16	4	64	0.1923	0.1893	0.1895
4	16	4	64	0.1947	0.1974	0.1883
2	8	99	64	0.0090	0.0093	0.0125
4	8	99	64	0.0091	0.0093	0.0133
2	16	99	64	0.0094	0.0086	0.0115
4	16	99	64	0.0094	0.0094	0.0128

TABLE A6 REPLENISHMENT FREQUENCY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.254	0.276	0.275
4	8	4	32	0.247	0.268	0.270
2	16	4	32	0.366	0.378	0.388
4	16	4	32	0.352	0.369	0.369
2	8	99	32	0.290	0.271	0.270
4	8	99	32	0.279	0.265	0.262
2	16	99	32	0.410	0.370	0.381
4	16	99	32	0.391	0.364	0.362
2	8	4	64	0.192	0.205	0.206
4	8	4	64	0.181	0.201	0.202
2	16	4	64	0.283	0.291	0.293
4	16	4	64	0.270	0.285	0.284
2	8	99	64	0.206	0.202	0.202
4	8	99	64	0.198	0.199	0.199
2	16	99	64	0.319	0.287	0.289
4	16	99	64	0.307	0.282	0.281

TABLE A7 ESTIMATED BIAS OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)
COLUMN (1) % EXCESS OF MEAN ACTUAL COST OVER MEAN FORECAST COST
COLUMN (2) + : BIAS FOR O.C.: POSITIVE ; - : NEGATIVE ; # : SIGNIFICANTLY POSITIVE ; = : SIGNIFICANTLY NEGATIVE
SUBCOLUMNS: PERIOD-END INVENTORY, STOCKOUT QUANTITY, STOCKOUT FREQUENCY, REPLENISHMENT QUANTITY, REPLENISHMENT FREQUENCY, COST

LEADTIME	MEAN	C(OUT)/C(IN)	C(FIX)/C(IN)	(1) (24,24,24)	(2) (24,24,24)
2	8	4	32	0.8	# + + + - #
4	8	4	32	2.2	# # + - - #
2	16	4	32	1.2	# + - + - #
4	16	4	32	3.1	# # + + - #
2	8	99	32	4.7	# # # + + #
4	8	99	32	8.8	# # # + - #
2	16	99	32	5.5	# # # - = #
4	16	99	32	10.4	# # # + - #
2	8	4	64	1.0	# + + - - #
4	8	4	64	1.7	# # + - - #
2	16	4	64	1.2	# + + + - #
4	16	4	64	2.3	# + - - - #
2	8	99	64	5.2	# # # - - #
4	8	99	64	8.3	# # # - - #
2	16	99	64	5.9	# # # + + #
4	16	99	64	10.5	# # # - - #

TABLE A8 ESTIMATED STANDARD DEVIATION OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	(24,24,24)
2	8	4	32	3.6
4	8	4	32	5.0
2	16	4	32	4.0
4	16	4	32	6.3
2	8	99	32	9.9
4	8	99	32	9.3
2	16	99	32	12.0
4	16	99	32	11.7
2	8	4	64	4.0
4	8	4	64	4.8
2	16	4	64	4.1
4	16	4	64	6.2
2	8	99	64	9.2
4	8	99	64	9.6
2	16	99	64	12.8
4	16	99	64	12.9

TABLE A9 VALUES FOR LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	15	15	15	16	16	15	14	18	27	36	29	22
8	4	32	PA	15	15	15	15	15	15	15	21	27	34	27	21
			(24,24)	15.9	15.9	15.9	15.9	15.9	15.9	15.9	22.0	28.2	34.4	28.2	22.0
			DP	13	13	13	14	14	13	8	16	25	33	26	19
8	4	64	PA	12	12	12	12	12	12	12	18	24	30	24	18
			(24,24)	12.8	12.8	12.8	12.8	12.8	12.8	12.8	18.6	24.5	30.4	24.5	18.6
			DP	33	33	33	33	33	33	32	39	49	59	50	42
8	99	32	PA	33	33	33	33	33	33	33	41	49	57	49	41
			(24,24)	34.2	34.2	34.2	34.2	34.2	34.2	34.2	42.6	50.7	58.7	50.7	42.6
			DP	32	32	32	32	32	32	29	38	48	57	49	40
8	99	64	PA	31	31	31	31	31	31	31	39	47	55	47	39
			(24,24)	32.1	32.1	32.1	32.1	32.1	32.1	32.1	40.2	48.2	55.9	48.2	40.2
			DP	33	33	33	32	34	35	29	44	55	74	60	46
16	4	32	PA	34	34	34	34	34	34	34	46	58	71	58	46
			(24,24)	34.1	34.1	34.1	34.1	34.1	34.1	34.1	46.6	59.1	71.7	59.1	46.6
			DP	30	29	29	30	31	30	27	36	52	70	56	43
16	4	64	PA	30	30	30	30	30	30	30	41	53	66	53	41
			(24,24)	30.1	30.1	30.1	30.1	30.1	30.1	30.1	42.1	54.3	66.6	54.3	42.1
			DP	57	57	57	57	57	59	55	72	86	105	89	73
16	99	32	PA	57	57	57	57	57	57	57	72	87	102	87	72
			(24,24)	58.4	58.4	58.4	58.4	58.4	58.4	58.4	73.9	89.1	104.0	89.1	73.9
			DP	55	55	55	55	57	54	53	68	85	103	87	71
16	99	64	PA	55	55	55	55	55	55	55	69	84	98	84	69
			(24,24)	55.6	55.6	55.6	55.6	55.6	55.6	55.6	70.8	85.6	100.2	85.6	70.8

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	37	38	38	37	36	37	40	53	57	57	50	44
8	4	32	PA	35	35	35	35	35	35	35	44	53	62	53	44
			(24,24)	36.5	36.5	36.5	36.5	36.5	36.5	36.5	45.4	54.1	62.5	54.1	45.4
			DP	45	45	43	41	40	40	46	63	64	63	56	50
8	4	64	PA	41	41	41	41	41	41	41	51	61	70	61	51
			(24,24)	42.2	42.2	42.2	42.2	42.2	42.2	42.2	52.1	61.4	70.5	61.4	52.1
			DP	52	53	53	52	50	54	55	61	77	75	67	59
8	99	32	PA	53	53	53	53	53	53	53	64	75	85	75	64
			(24,24)	54.8	54.8	54.8	54.8	54.8	54.8	54.8	66.0	76.6	86.7	76.6	66.0
			DP	61	61	59	57	56	57	62	84	82	80	72	66
8	99	64	PA	60	60	60	60	60	60	60	72	84	95	84	72
			(24,24)	61.5	61.5	61.5	61.5	61.5	61.5	61.5	73.7	85.1	96.0	85.1	73.7
			DP	63	63	61	65	62	56	66	80	103	104	89	75
16	4	32	PA	62	62	62	62	62	62	62	78	93	109	93	78
			(24,24)	62.2	62.2	62.2	62.2	62.2	62.2	62.2	78.5	93.9	102.3	93.9	78.5
			DP	71	72	74	72	68	71	80	81	113	112	98	85
16	4	64	PA	70	70	70	70	70	70	70	86	103	120	103	86
			(24,24)	70.2	70.2	70.2	70.2	70.2	70.2	70.2	87.6	104.5	121.0	104.5	87.6
			DP	82	83	82	82	84	77	67	108	130	128	112	95
16	99	32	PA	85	85	85	85	85	85	85	104	122	140	122	104
			(24,24)	86.5	86.5	86.5	86.5	86.5	86.5	86.5	105.8	123.7	131.2	123.7	105.8
			DP	92	90	97	93	87	78	94	109	139	136	120	106
16	99	64	PA	95	95	95	95	95	95	95	114	134	152	134	114
			(24,24)	95.7	95.7	95.7	95.7	95.7	95.7	95.7	116.3	135.9	154.7	135.9	116.3

TABLE A9 VALUES FOR BIG S - LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	22	23	23	21	20	22	26	35	30	21	21	22
8	4	32	PA	20	20	20	20	20	20	20	23	26	28	26	23
			(24,24)	20.6	20.6	20.6	20.6	20.6	20.6	20.6	23.4	25.9	28.1	25.9	23.4
			DP	32	32	30	27	25	27	38	47	39	30	30	31
8	4	64	PA	29	29	29	29	29	29	29	33	37	40	37	33
			(24,24)	29.4	29.4	29.4	29.4	29.4	29.4	29.4	33.5	37.0	40.1	37.0	33.5
			DP	19	20	20	19	17	21	23	22	28	16	17	17
8	99	32	PA	20	20	20	20	20	20	20	23	26	28	26	23
			(24,24)	20.6	20.6	20.6	20.6	20.6	20.6	20.6	23.4	25.9	28.1	25.9	23.4
			DP	29	29	27	25	24	25	33	46	34	23	23	26
8	99	64	PA	29	29	29	29	29	29	29	33	37	40	37	33
			(24,24)	29.4	29.4	29.4	29.4	29.4	29.4	29.4	33.5	37.0	40.1	37.0	33.5
			DP	30	30	28	33	28	21	37	36	48	30	29	29
16	4	32	PA	28	28	28	28	28	28	28	32	35	38	35	32
			(24,24)	28.1	28.1	28.1	28.1	28.1	28.1	28.1	31.9	34.8	30.5	34.8	31.9
			DP	41	43	45	42	37	41	53	45	61	42	42	42
16	4	64	PA	40	40	40	40	40	40	40	45	50	54	50	45
			(24,24)	40.0	40.0	40.0	40.0	40.0	40.0	40.0	45.5	50.2	54.4	50.2	45.5
			DP	25	26	25	25	27	18	12	36	44	23	23	22
16	99	32	PA	28	28	28	28	28	28	28	32	35	38	35	32
			(24,24)	28.0	28.0	28.0	28.0	28.0	28.0	28.0	31.9	34.6	27.2	34.6	31.9
			DP	37	35	42	38	30	24	41	41	54	33	33	35
16	99	64	PA	40	40	40	40	40	40	40	45	50	54	50	45
			(24,24)	40.0	40.0	40.0	40.0	40.0	40.0	40.0	45.5	50.2	54.4	50.2	45.5

TABLE A9 VALUES FOR LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	29	29	29	29	28	32	39	50	50	49	42	35
8	4	32	PA	29	29	29	29	29	35	42	48	48	48	42	35
			(24,24)	30.0	30.0	30.0	30.0	30.0	36.4	42.8	49.2	49.2	49.2	42.8	36.4
			DP	27	27	28	26	22	28	37	47	47	46	39	32
8	4	64	PA	26	26	26	26	26	32	38	44	44	44	38	32
			(24,24)	26.6	26.6	26.6	26.6	26.6	32.6	38.8	45.0	45.0	45.0	38.8	32.6
			DP	50	51	51	50	49	56	65	75	76	75	67	58
8	99	32	PA	51	51	51	51	51	59	67	74	74	74	67	59
			(24,24)	52.1	52.1	52.1	52.1	52.1	60.2	68.1	76.0	76.0	76.0	68.1	60.2
			DP	49	49	49	49	47	54	63	73	74	73	65	57
8	99	64	PA	48	48	48	48	48	56	64	71	71	71	64	56
			(24,24)	49.4	49.4	49.4	49.4	49.4	57.3	65.1	72.7	72.7	72.7	65.1	57.3
			DP	60	59	61	62	55	71	81	100	100	100	87	74
16	4	32	PA	61	61	61	61	61	73	86	98	98	98	86	73
			(24,24)	61.6	61.6	61.6	61.6	61.6	74.5	87.3	100.1	100.1	100.1	87.3	74.5
			DP	56	57	57	55	53	63	77	96	96	96	83	68
16	4	64	PA	56	56	56	56	56	68	81	93	93	93	81	68
			(24,24)	57.1	57.1	57.1	57.1	57.1	69.5	82.1	94.7	94.7	94.7	82.1	69.5
			DP	89	88	89	91	86	103	116	134	135	135	120	104
16	99	32	PA	89	89	89	89	89	104	119	133	133	133	119	104
			(24,24)	91.1	91.1	91.1	91.1	91.1	106.2	121.0	135.8	135.8	135.8	121.0	106.2
			DP	86	87	88	86	87	99	114	132	133	133	118	102
16	99	64	PA	86	86	86	86	86	100	115	129	129	129	115	100
			(24,24)	87.4	87.4	87.4	87.4	87.4	102.3	116.9	131.4	131.4	131.4	116.9	102.3

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	53	52	51	52	55	59	74	74	73	72	65	59
8	4	32	PA	50	50	50	50	50	58	67	74	74	74	67	58
			(24,24)	51.3	51.3	51.3	51.3	51.3	59.5	67.6	75.5	75.5	75.5	67.6	59.5
			DP	58	57	55	56	58	80	80	79	78	78	72	66
8	4	64	PA	56	56	56	56	56	65	73	81	81	81	73	65
			(24,24)	57.1	57.1	57.1	57.1	57.1	65.7	74.3	82.7	82.7	82.7	74.3	65.7
			DP	71	70	68	70	77	78	96	96	94	92	84	77
8	99	32	PA	72	72	72	72	72	82	92	100	100	100	92	82
			(24,24)	73.4	73.4	73.4	73.4	73.4	83.3	93.0	102.3	102.3	102.3	93.0	83.3
			DP	77	76	75	76	80	103	103	101	99	98	91	85
8	99	64	PA	78	78	78	78	78	89	99	108	108	108	99	89
			(24,24)	80.0	80.0	80.0	80.0	80.0	90.4	100.5	110.4	110.4	110.4	100.5	90.4
			DP	90	94	91	84	94	107	130	134	133	132	118	104
16	4	32	PA	90	90	90	90	90	104	120	134	134	134	120	104
			(24,24)	90.8	90.8	90.8	90.8	90.8	106.1	121.1	136.0	136.0	136.0	121.1	106.1
			DP	103	99	96	99	109	108	143	143	142	139	125	114
16	4	64	PA	97	97	97	97	97	113	129	144	144	144	129	113
			(24,24)	98.6	98.6	98.6	98.6	98.6	114.6	130.3	145.8	145.8	145.8	130.3	114.6
			DP	114	117	117	109	100	139	160	164	163	160	144	129
16	99	32	PA	116	118	118	118	118	135	153	169	169	169	153	135
			(24,24)	120.2	120.2	120.2	120.2	120.2	137.8	154.8	171.7	171.7	171.7	154.8	137.8
			DP	130	126	119	111	125	140	174	174	171	168	151	137
16	99	64	PA	127	127	127	127	127	145	163	180	180	180	163	145
			(24,24)	129.0	129.0	129.0	129.0	129.0	147.3	165.1	182.5	182.5	182.5	165.1	147.3

TABLE A9 VALUES FOR BIG S - LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	24	23	22	23	27	27	35	24	23	23	23	24
8	4	32	PA	21	21	21	21	21	23	25	26	26	26	25	23
			(24,24)	21.3	21.3	21.3	21.3	21.3	23.1	24.9	26.3	26.3	26.3	24.9	23.1
			DP	31	30	27	30	36	52	43	32	31	32	33	34
8	4	64	PA	30	30	30	30	30	33	35	37	37	37	35	33
			(24,24)	30.5	30.5	30.5	30.5	30.5	33.1	35.5	37.7	37.7	37.7	35.5	33.1
			DP	21	19	17	20	28	22	31	21	18	17	17	19
8	99	32	PA	21	21	21	21	21	23	25	26	26	26	25	23
			(24,24)	21.3	21.3	21.3	21.3	21.3	23.1	24.9	26.3	26.3	26.3	24.9	23.1
			DP	28	27	26	27	33	49	40	28	25	25	26	28
8	99	64	PA	30	30	30	30	30	33	35	37	37	37	35	33
			(24,24)	30.5	30.5	30.5	30.5	30.5	33.1	35.5	37.7	37.7	37.7	35.5	33.1
			DP	30	35	30	22	39	36	49	34	33	32	31	30
16	4	32	PA	29	29	29	29	29	31	34	36	36	36	34	31
			(24,24)	29.1	29.1	29.1	29.1	29.1	31.6	33.8	35.9	35.9	35.9	33.8	31.6
			DP	47	42	39	44	56	45	66	47	46	43	42	46
16	4	64	PA	41	41	41	41	41	45	48	51	51	51	48	45
			(24,24)	41.5	41.5	41.5	41.5	41.5	45.1	48.2	51.1	51.1	51.1	48.2	45.1
			DP	25	28	28	18	14	36	44	30	28	25	24	25
16	99	32	PA	29	29	29	29	29	31	34	36	36	36	34	31
			(24,24)	29.1	29.1	29.1	29.1	29.1	31.6	33.8	35.9	35.9	35.9	33.8	31.6
			DP	44	39	31	25	41	41	60	42	38	35	33	35
16	99	64	PA	41	41	41	41	41	45	48	51	51	51	48	45
			(24,24)	41.5	41.5	41.5	41.5	41.5	45.1	48.2	51.1	51.1	51.1	48.2	45.1

TABLE A10 STANDARD DEVIATION OF LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I
STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	2.4	2.4	2.4	2.4	2.4	2.4	2.4	3.2	4.0	4.8	4.0	3.2
4	8	4	32	4.1	4.1	4.1	4.1	4.1	4.9	5.7	6.5	6.5	6.5	5.7	4.9
2	8	4	64	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.9	3.6	4.4	3.6	2.9
4	8	4	64	3.7	3.7	3.7	3.7	3.7	4.6	5.3	6.1	6.1	6.1	5.3	4.6
2	8	99	32	5.4	5.4	5.4	5.4	5.4	5.4	5.4	6.5	7.5	8.5	7.5	6.5
4	8	99	32	7.6	7.6	7.6	7.6	7.6	8.5	9.5	10.5	10.5	10.5	9.5	8.5
2	8	99	64	4.9	4.9	4.9	4.9	4.9	4.9	4.9	6.0	6.9	7.9	6.9	6.0
4	8	99	64	7.0	7.0	7.0	7.0	7.0	8.0	8.9	9.8	9.8	9.8	8.9	8.0
2	16	4	32	3.3	3.3	3.3	3.3	3.3	3.3	3.3	4.5	5.7	6.8	5.7	4.5
4	16	4	32	5.8	5.8	5.8	5.8	5.8	6.9	8.0	9.2	9.2	9.2	8.0	6.9
2	16	4	64	3.2	3.2	3.2	3.2	3.2	3.2	3.2	4.3	5.3	6.5	5.3	4.3
4	16	4	64	5.4	5.4	5.4	5.4	5.4	6.6	7.7	8.8	8.8	8.8	7.7	6.6
2	16	99	32	6.8	6.8	6.8	6.8	6.8	6.8	6.8	8.2	9.5	10.9	9.5	8.2
4	16	99	32	9.6	9.6	9.6	9.6	9.6	10.9	12.3	13.5	13.5	13.5	12.3	10.9
2	16	99	64	6.2	6.2	6.2	6.2	6.2	6.2	6.2	7.6	8.8	10.2	8.8	7.6
4	16	99	64	9.0	9.0	9.0	9.0	9.0	10.3	11.5	12.7	12.7	12.7	11.5	10.3

TABLE A10 STANDARD DEVIATION OF BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL I
STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	3.7	3.7	3.7	3.7	3.7	3.7	3.7	4.7	5.6	6.5	5.6	4.7
4	8	4	32	5.4	5.4	5.4	5.4	5.4	6.3	7.2	8.1	8.1	8.1	7.2	6.3
2	8	4	64	3.9	3.9	3.9	3.9	3.9	3.9	3.9	4.9	5.9	6.9	5.9	4.9
4	8	4	64	5.6	5.6	5.6	5.6	5.6	6.6	7.5	8.4	8.4	8.4	7.5	6.6
2	8	99	32	6.7	6.7	6.7	6.7	6.7	6.7	6.7	7.9	9.2	10.3	9.2	7.9
4	8	99	32	8.8	8.8	8.8	8.8	8.8	10.0	11.0	12.1	12.1	12.1	11.0	10.0
2	8	99	64	6.7	6.7	6.7	6.7	6.7	6.7	6.7	8.0	9.3	10.4	9.3	8.0
4	8	99	64	8.8	8.8	8.8	8.8	8.8	10.0	11.1	12.2	12.2	12.2	11.1	10.0
2	16	4	32	4.6	4.6	4.6	4.6	4.6	4.6	4.6	5.9	7.0	8.0	7.0	5.9
4	16	4	32	7.1	7.1	7.1	7.1	7.1	8.3	9.5	10.8	10.8	10.8	9.5	8.3
2	16	4	64	4.9	4.9	4.9	4.9	4.9	4.9	4.9	6.3	7.5	8.9	7.5	6.3
4	16	4	64	7.2	7.2	7.2	7.2	7.2	8.6	9.8	11.0	11.0	11.0	9.8	8.6
2	16	99	32	8.1	8.1	8.1	8.1	8.1	8.1	8.1	9.7	11.3	14.5	11.3	9.7
4	16	99	32	11.0	11.0	11.0	11.0	11.0	12.4	13.8	15.2	15.2	15.2	13.8	12.4
2	16	99	64	8.1	8.1	8.1	8.1	8.1	8.1	8.1	9.7	11.2	12.8	11.2	9.7
4	16	99	64	10.9	10.9	10.9	10.9	10.9	12.4	13.7	15.1	15.1	15.1	13.7	12.4

Appendix C

Single-item Data

Model II

Summary of Data for 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with:

Optimal Policies (DP)

Power Approximation (PA)

Statistical Power Approximation

		page
Table A1	Average Total Cost	C1
A3	Period-End Inventory	C2
A4	Period-End Backlog as Proportion of Mean Demand	C3
A5	Frequency of Periods with Backlog	C4
A6	Replenishment Frequency	C5
A7	Estimated Bias of Forecast of Total Cost	C6
A8	Estimated Standard Deviation of Forecast of Total Cost	C7
A9	Values for (s_i, S_i)	C8 to C13
A10	Standard Deviations of (s_i, S_i) Values	C14 to C15

Note: For corresponding data in MacCormick (1974), see tables of the same number in Appendices A of those reports.

TABLE A1 AVERAGE TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

VALUES FOR RULES OTHER THAN THE OPTIMAL DP ARE % EXCESS OVER DP VALUE

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	25.3	0.7	3.8
4	8	4	32	28.1	0.7	6.7
2	16	4	32	35.6	0.3	3.2
4	16	4	32	39.4	0.4	5.5
2	8	99	32	41.7	0.7	9.9
4	8	99	32	47.6	0.8	13.2
2	16	99	32	57.1	0.7	9.2
4	16	99	32	65.4	0.6	12.1
2	8	4	64	32.4	1.1	3.3
4	8	4	64	34.8	1.2	5.2
2	16	4	64	45.8	0.5	2.5
4	16	4	64	49.1	0.7	4.7
2	8	99	64	49.4	1.3	8.0
4	8	99	64	55.1	1.1	12.5
2	16	99	64	68.4	0.8	6.9
4	16	99	64	76.5	0.8	10.1

TABLE A3 PERIOD-END INVENTORY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	11.4	10.6	11.9
4	8	4	32	13.4	12.8	14.3
2	16	4	32	16.0	16.2	16.9
4	16	4	32	18.8	18.7	20.3
2	8	99	32	28.0	28.9	30.9
4	8	99	32	33.5	35.1	37.3
2	16	99	32	38.1	39.7	41.7
4	16	99	32	45.8	47.8	50.3
2	8	4	64	14.1	12.9	13.8
4	8	4	64	15.8	14.6	15.9
2	16	4	64	19.7	18.9	19.9
4	16	4	64	22.3	21.0	22.6
2	8	99	64	31.5	32.2	33.7
4	8	99	64	36.6	37.5	39.7
2	16	99	64	42.6	44.3	46.1
4	16	99	64	50.0	51.2	53.7

TABLE A4 PERIOD-END BACKLOG AS PROPORTION OF MEAN DEMAND

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1743	0.1870	0.1731
4	8	4	32	0.2112	0.2151	0.2188
2	16	4	32	0.1176	0.1120	0.1150
4	16	4	32	0.1440	0.1387	0.1449
2	8	99	32	0.0057	0.0054	0.0078
4	8	99	32	0.0069	0.0056	0.0102
2	16	99	32	0.0037	0.0035	0.0053
4	16	99	32	0.0043	0.0039	0.0071
2	8	4	64	0.1879	0.2092	0.2034
4	8	4	64	0.2231	0.2393	0.2443
2	16	4	64	0.1320	0.1312	0.1297
4	16	4	64	0.1531	0.1593	0.1654
2	8	99	64	0.0058	0.0060	0.0083
4	8	99	64	0.0069	0.0069	0.0120
2	16	99	64	0.0037	0.0038	0.0053
4	16	99	64	0.0046	0.0048	0.0078

TABLE A5 FREQUENCY OF PERIODS WITH BACKLOG

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1895	0.2021	0.1847
4	8	4	32	0.1920	0.1966	0.1906
2	16	4	32	0.1910	0.1833	0.1833
4	16	4	32	0.1943	0.1890	0.1881
2	8	99	32	0.0090	0.0084	0.0113
4	8	99	32	0.0092	0.0075	0.0123
2	16	99	32	0.0094	0.0088	0.0119
4	16	99	32	0.0093	0.0083	0.0131
2	8	4	64	0.1901	0.2073	0.1990
4	8	4	64	0.1908	0.2025	0.1995
2	16	4	64	0.1944	0.1946	0.1891
4	16	4	64	0.1921	0.1995	0.1982
2	8	99	64	0.0090	0.0092	0.0118
4	8	99	64	0.0092	0.0090	0.0140
2	16	99	64	0.0092	0.0091	0.0117
4	16	99	64	0.0095	0.0098	0.0140

TABLE A6 REPLENISHMENT FREQUENCY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.260	0.279	0.277
4	8	4	32	0.246	0.268	0.270
2	16	4	32	0.377	0.385	0.389
4	16	4	32	0.356	0.375	0.376
2	8	99	32	0.286	0.276	0.272
4	8	99	32	0.274	0.266	0.266
2	16	99	32	0.408	0.380	0.382
4	16	99	32	0.399	0.370	0.369
2	8	4	64	0.193	0.206	0.207
4	8	4	64	0.185	0.202	0.202
2	16	4	64	0.277	0.293	0.293
4	16	4	64	0.266	0.286	0.286
2	8	99	64	0.208	0.204	0.204
4	8	99	64	0.204	0.200	0.201
2	16	99	64	0.311	0.291	0.291
4	16	99	64	0.300	0.285	0.284

TABLE A7 ESTIMATED BIAS OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)
COLUMN (1) % EXCESS OF MEAN ACTUAL COST OVER MEAN FORECAST COST
COLUMN (2) + : BIAS FOR O.C.: POSITIVE ; - : NEGATIVE ; # : SIGNIFICANTLY POSITIVE ; = : SIGNIFICANTLY NEGATIVE
SUBCOLUMNS: PERIOD-END INVENTORY, STOCKOUT QUANTITY, STOCKOUT FREQUENCY, REPLENISHMENT QUANTITY, REPLENISHMENT FREQUENCY, COST

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	(1) (24,24,24)	(2) (24,24,24)
2	8	4	32	0.9	# + - - - #
4	8	4	32	2.3	# # + - + #
2	16	4	32	1.0	# + - - - #
4	16	4	32	3.4	# # + + - #
2	8	99	32	4.9	# # # = - #
4	8	99	32	8.1	# # # + + #
2	16	99	32	6.7	# # # - - #
4	16	99	32	10.2	# # # - - #
2	8	4	64	0.7	# + + - - #
4	8	4	64	2.1	# # + + - #
2	16	4	64	0.9	# + - - - #
4	16	4	64	2.7	# # + - + #
2	8	99	64	4.5	+ # # + + #
4	8	99	64	9.4	# # # - - #
2	16	99	64	5.3	# # # + - #
4	16	99	64	10.4	# # # + + #

TABLE A8 ESTIMATED STANDARD DEVIATION OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	(24,24,24)
2	8	4	32	3.4
4	8	4	32	5.0
2	16	4	32	4.3
4	16	4	32	6.1
2	8	99	32	9.3
4	8	99	32	10.2
2	16	99	32	11.0
4	16	99	32	16.7
2	8	4	64	3.9
4	8	4	64	5.2
2	16	4	64	4.4
4	16	4	64	6.3
2	8	99	64	10.5
4	8	99	64	10.0
2	16	99	64	12.8
4	16	99	64	16.6

TABLE A9 VALUES FOR LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	15	15	16	15	15	16	19	27	31	29	22	18
8	4	32	PA	15	15	15	15	15	17	21	27	30	27	21	17
			(24,24)	15.9	15.9	15.9	15.9	15.9	17.9	21.9	28.1	30.2	28.1	21.9	17.9
			DP	13	13	14	14	12	12	16	25	28	26	19	15
8	4	64	PA	12	12	12	12	12	14	18	24	26	24	18	14
			(24,24)	12.9	12.9	12.9	12.9	12.9	14.7	18.6	24.4	26.4	24.4	18.6	14.7
			DP	33	33	33	33	33	35	40	49	53	50	42	36
8	99	32	PA	33	33	33	33	33	36	41	49	52	49	41	36
			(24,24)	34.2	34.2	34.2	34.2	34.2	37.0	42.6	50.7	53.3	50.7	42.6	37.0
			DP	32	32	32	32	32	32	38	48	52	49	40	35
8	99	64	PA	31	31	31	31	31	34	39	47	50	47	39	34
			(24,24)	32.1	32.1	32.1	32.1	32.1	34.8	40.2	48.1	50.8	48.1	40.2	34.8
			DP	33	33	33	34	32	36	43	56	63	60	47	38
16	4	32	PA	34	34	34	34	34	38	46	58	62	58	46	38
			(24,24)	34.1	34.1	34.1	34.1	34.1	38.3	46.6	59.1	63.3	59.1	46.6	38.3
			DP	30	30	30	29	29	31	37	52	59	56	43	34
16	4	64	PA	30	30	30	30	30	34	41	53	57	53	41	34
			(24,24)	30.2	30.2	30.2	30.2	30.2	34.1	42.1	54.2	58.3	54.2	42.1	34.1
			DP	57	57	57	57	56	61	71	87	93	89	73	63
16	99	32	PA	57	57	57	57	57	62	72	87	92	87	72	62
			(24,24)	58.4	58.4	58.4	58.4	58.4	63.6	73.9	89.0	94.1	89.0	73.9	63.6
			DP	55	55	56	55	54	59	68	85	92	87	72	61
16	99	64	PA	55	55	55	55	55	60	69	84	89	84	69	60
			(24,24)	55.6	55.6	55.6	55.6	55.6	60.8	70.7	85.7	90.5	85.7	70.7	60.8

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	37	37	37	37	38	41	51	56	55	50	44	40
8	4	32	PA	35	35	35	35	35	38	44	53	56	53	44	38
			(24,24)	36.5	36.5	36.5	36.5	36.5	39.5	45.3	54.0	56.9	54.0	45.3	39.5
			DP	45	44	42	41	42	54	62	63	61	57	50	47
8	4	64	PA	41	41	41	41	41	45	51	61	64	61	51	45
			(24,24)	42.3	42.3	42.3	42.3	42.3	45.6	52.0	61.4	64.4	61.4	52.0	45.6
			DP	53	52	52	53	55	54	70	75	73	67	59	55
8	99	32	PA	53	53	53	53	53	57	64	75	78	75	64	57
			(24,24)	54.8	54.8	54.8	54.8	54.8	58.6	66.0	76.6	80.0	76.6	66.0	58.6
			DP	60	60	59	59	59	74	82	82	79	73	66	62
8	99	64	PA	60	60	60	60	60	65	72	84	88	84	72	65
			(24,24)	61.6	61.6	61.6	61.6	61.6	65.7	73.7	85.1	88.8	85.1	73.7	65.7
			DP	62	63	63	61	63	67	81	95	98	89	76	67
16	4	32	PA	62	62	62	62	62	67	78	93	98	93	78	67
			(24,24)	62.2	62.2	62.2	62.2	62.2	67.7	78.5	93.8	98.1	93.8	78.5	67.7
			DP	73	72	71	72	73	80	94	110	107	98	85	76
16	4	64	PA	70	70	70	70	70	76	86	103	108	103	86	76
			(24,24)	70.2	70.2	70.2	70.2	70.2	76.1	87.6	104.5	110.0	104.5	87.6	76.1
			DP	82	83	83	80	81	92	108	122	123	112	97	87
16	99	32	PA	85	85	85	85	85	91	104	122	128	122	104	91
			(24,24)	86.5	86.5	86.5	86.5	86.5	93.1	105.8	123.5	128.3	123.5	105.8	93.1
			DP	95	93	90	90	100	94	112	137	132	121	105	96
16	99	64	PA	95	95	95	95	95	102	114	134	140	134	114	102
			(24,24)	95.7	95.7	95.7	95.7	95.7	102.7	116.2	135.9	142.2	135.9	116.2	102.7

TABLE A9 VALUES FOR BIG S - LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	22	22	21	22	23	25	32	29	24	21	22	22
8	4	32	PA	20	20	20	20	20	21	23	26	26	26	23	21
			(24,24)	20.6	20.6	20.6	20.6	20.6	21.6	23.4	25.9	26.7	25.9	23.4	21.6
			DP	32	31	28	27	30	42	46	38	33	31	31	32
8	4	64	PA	29	29	29	29	29	31	33	37	38	37	33	31
			(24,24)	29.4	29.4	29.4	29.4	29.4	30.9	33.5	37.0	38.0	37.0	33.5	30.9
			DP	20	19	19	20	22	19	30	26	20	17	17	19
8	99	32	PA	20	20	20	20	20	21	23	26	26	26	23	21
			(24,24)	20.6	20.6	20.6	20.6	20.6	21.6	23.4	25.9	26.7	25.9	23.4	21.6
			DP	28	28	27	27	26	42	44	34	27	24	26	27
8	99	64	PA	29	29	29	29	29	31	33	37	38	37	33	31
			(24,24)	29.4	29.4	29.4	29.4	29.4	30.9	33.5	37.0	38.0	37.0	33.5	30.9
			DP	29	30	30	27	31	31	38	39	35	29	29	29
16	4	32	PA	28	28	28	28	28	29	32	35	36	35	32	29
			(24,24)	28.0	28.0	28.0	28.0	28.0	29.4	31.9	34.7	34.8	34.7	31.9	29.4
			DP	43	42	41	43	44	49	57	58	48	42	42	42
16	4	64	PA	40	40	40	40	40	42	45	50	51	50	45	42
			(24,24)	40.0	40.0	40.0	40.0	40.0	42.0	45.5	50.3	51.7	50.3	45.5	42.0
			DP	25	26	26	23	25	31	37	35	30	23	24	24
16	99	32	PA	28	28	28	28	28	29	32	35	36	35	32	29
			(24,24)	28.0	28.0	28.0	28.0	28.0	29.4	31.9	34.4	34.2	34.4	31.9	29.4
			DP	40	38	34	35	46	35	44	52	40	34	33	35
16	99	64	PA	40	40	40	40	40	42	45	50	51	50	45	42
			(24,24)	40.0	40.0	40.0	40.0	40.0	42.0	45.5	50.2	51.7	50.2	45.5	42.0

TABLE A9 VALUES FOR LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT)/C(IN)	C(FIX)/C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	29	29	28	30	32	40	46	50	47	42	36	31
8	4	32	PA	29	29	29	31	35	42	46	48	46	42	35	31
			(24,24)	30.0	30.0	30.0	32.1	36.3	42.7	47.0	49.1	47.0	42.7	36.3	32.1
			DP	27	27	26	25	29	37	44	47	44	39	33	29
8	4	64	PA	26	26	26	28	32	38	42	44	42	38	32	28
			(24,24)	26.5	26.5	26.5	28.5	32.6	38.8	42.9	44.9	42.9	38.8	32.6	28.5
			DP	50	50	50	52	56	65	72	75	72	67	59	53
8	99	32	PA	51	51	51	53	59	67	72	74	72	67	59	53
			(24,24)	52.0	52.0	52.0	54.8	60.1	68.1	73.3	75.9	73.3	68.1	60.1	54.8
			DP	49	49	48	50	54	64	70	74	71	65	57	51
8	99	64	PA	48	48	48	51	56	64	69	71	69	64	56	51
			(24,24)	49.4	49.4	49.4	52.0	57.2	65.0	70.2	72.7	70.2	65.0	57.2	52.0
			DP	60	60	58	62	69	83	93	100	96	87	73	64
16	4	32	PA	61	61	61	65	73	86	94	98	94	86	73	65
			(24,24)	61.5	61.5	61.5	65.8	74.3	87.1	95.7	100.0	95.7	87.1	74.3	65.8
			DP	56	56	55	58	64	78	90	96	92	83	69	61
16	4	64	PA	56	56	56	60	68	81	89	93	89	81	68	60
			(24,24)	57.0	57.0	57.0	61.2	69.5	82.0	90.3	94.5	90.3	82.0	69.5	61.2
			DP	89	89	88	93	102	117	128	135	130	120	105	94
16	99	32	PA	89	89	89	94	104	119	129	133	129	119	104	94
			(24,24)	91.0	91.0	91.0	96.0	106.0	120.9	130.8	135.7	130.8	120.9	106.0	96.0
			DP	87	86	86	90	99	114	126	133	128	117	102	92
16	99	64	PA	86	86	86	91	100	115	124	129	124	115	100	91
			(24,24)	87.4	87.4	87.4	92.3	102.2	116.8	126.5	131.3	126.5	116.8	102.2	92.3

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	52	52	53	56	64	72	74	73	70	65	59	54
8	4	32	PA	50	50	50	53	58	67	72	74	72	67	58	53
			(24,24)	51.3	51.3	51.3	54.0	59.4	67.6	72.9	75.4	72.9	67.6	59.4	54.0
			DP	57	57	57	64	78	79	79	79	76	72	66	61
8	4	64	PA	56	56	56	59	65	73	79	81	79	73	65	59
			(24,24)	57.0	57.0	57.0	59.9	65.7	74.3	79.8	82.6	79.8	74.3	65.7	59.9
			DP	70	71	72	76	83	95	95	94	90	85	77	73
8	99	32	PA	72	72	72	75	82	92	98	100	98	92	82	75
			(24,24)	73.3	73.3	73.3	76.7	83.2	92.9	99.2	102.2	99.2	92.9	83.2	76.7
			DP	77	77	77	83	101	102	101	100	96	91	84	80
8	99	64	PA	78	78	78	82	89	99	106	108	106	99	89	82
			(24,24)	79.9	79.9	79.9	83.4	90.3	100.5	107.1	110.3	107.1	100.5	90.3	83.4
			DP	91	90	93	95	108	122	133	133	128	118	104	96
16	4	32	PA	90	90	90	95	104	120	129	134	129	120	104	95
			(24,24)	90.6	90.6	90.6	95.7	105.9	121.0	130.9	135.9	130.9	121.0	105.9	95.7
			DP	99	100	101	110	121	140	142	141	136	127	114	105
16	4	64	PA	97	97	97	102	113	129	139	144	139	129	113	102
			(24,24)	98.5	98.5	98.5	103.9	114.5	130.1	140.5	145.6	140.5	130.1	114.5	103.9
			DP	116	113	114	124	139	151	162	162	155	144	129	121
16	99	32	PA	118	118	118	124	135	153	164	169	164	153	135	124
			(24,24)	120.1	120.1	120.1	125.9	137.6	154.7	166.0	171.6	166.0	154.7	137.6	125.9
			DP	124	124	131	125	144	171	173	171	164	153	139	130
16	99	64	PA	127	127	127	133	145	163	174	180	174	163	145	133
			(24,24)	128.8	128.8	128.8	135.0	147.2	165.0	176.6	182.4	176.6	165.0	147.2	135.0

TABLE A9 VALUES FOR BIG S - LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	23	23	25	26	32	32	28	23	23	23	23	23
8	4	32	PA	21	21	21	22	23	25	26	26	26	25	23	22
			(24,24)	21.3	21.3	21.3	22.0	23.1	24.9	25.9	26.3	25.9	24.9	23.1	22.0
			DP	30	30	31	39	49	42	35	32	32	33	33	32
8	4	64	PA	30	30	30	31	33	35	37	37	37	35	33	31
			(24,24)	30.5	30.5	30.5	31.4	33.1	35.5	36.9	37.6	36.9	35.5	33.1	31.4
			DP	20	21	22	24	27	30	23	19	18	18	18	20
8	99	32	PA	21	21	21	22	23	25	26	26	26	25	23	22
			(24,24)	21.3	21.3	21.3	22.0	23.1	24.9	25.9	26.3	25.9	24.9	23.1	22.0
			DP	28	28	29	33	37	38	31	26	25	26	27	29
8	99	64	PA	30	30	30	31	33	35	37	37	37	35	33	31
			(24,24)	30.5	30.5	30.5	31.4	33.1	35.5	36.9	37.7	36.9	35.5	33.1	31.4
			DP	31	30	35	33	39	39	40	33	32	31	31	32
16	4	32	PA	29	29	29	30	31	34	35	36	35	34	31	30
			(24,24)	29.1	29.1	29.1	30.0	31.6	33.8	35.2	35.9	35.2	33.8	31.6	30.0
			DP	43	44	46	52	57	62	52	45	44	44	45	44
16	4	64	PA	41	41	41	42	45	48	50	51	50	48	45	42
			(24,24)	41.5	41.5	41.5	42.7	45.0	48.2	50.2	51.1	50.2	48.2	45.0	42.7
			DP	27	24	26	31	37	34	34	27	25	24	24	27
16	99	32	PA	29	29	29	30	31	34	35	36	35	34	31	30
			(24,24)	29.1	29.1	29.1	30.0	31.6	33.8	35.2	35.9	35.2	33.8	31.6	30.0
			DP	37	38	45	35	45	57	47	38	36	36	37	38
16	99	64	PA	41	41	41	42	45	48	50	51	50	48	45	42
			(24,24)	41.5	41.5	41.5	42.7	45.0	48.2	50.2	51.1	50.2	48.2	45.0	42.7

TABLE A10 STANDARD DEVIATION OF LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II
STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	2.3	2.3	2.3	2.3	2.3	2.6	3.2	4.0	4.3	4.0	3.2	2.6
4	8	4	32	4.1	4.1	4.1	4.3	4.8	5.6	6.2	6.4	6.2	5.6	4.8	4.3
2	8	4	64	2.2	2.2	2.2	2.2	2.2	2.4	2.9	3.7	4.0	3.7	2.9	2.4
4	8	4	64	3.8	3.8	3.8	4.0	4.5	5.3	5.8	6.1	5.8	5.3	4.5	4.0
2	8	99	32	5.4	5.4	5.4	5.4	5.4	5.8	6.5	7.5	7.9	7.5	6.5	5.8
4	8	99	32	7.5	7.5	7.5	7.8	8.6	9.5	10.1	10.5	10.1	9.5	8.6	7.8
2	8	99	64	4.9	4.9	4.9	4.9	4.9	5.3	5.9	7.0	7.3	7.0	5.9	5.3
4	8	99	64	7.0	7.0	7.0	7.3	7.9	8.9	9.5	9.8	9.5	8.9	7.9	7.3
2	16	4	32	3.4	3.4	3.4	3.4	3.4	3.8	4.5	5.7	6.0	5.7	4.5	3.8
4	16	4	32	5.7	5.7	5.7	6.1	6.8	8.0	8.8	9.1	8.8	8.0	6.8	6.1
2	16	4	64	3.2	3.2	3.2	3.2	3.2	3.5	4.3	5.4	5.8	5.4	4.3	3.5
4	16	4	64	5.4	5.4	5.4	5.8	6.5	7.6	8.4	8.7	8.4	7.6	6.5	5.8
2	16	99	32	6.8	6.8	6.8	6.8	6.8	7.3	8.2	9.5	10.0	9.5	8.2	7.3
4	16	99	32	9.6	9.6	9.6	10.1	11.0	12.2	13.1	13.5	13.1	12.2	11.0	10.1
2	16	99	64	6.2	6.2	6.2	6.2	6.2	6.6	7.6	8.9	9.4	8.9	7.6	6.6
4	16	99	64	8.9	8.9	8.9	9.4	10.2	11.5	12.3	12.7	12.3	11.5	10.2	9.4

TABLE A10 STANDARD DEVIATION OF BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL II
STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	3.7	3.7	3.7	3.7	3.7	4.0	4.7	5.6	6.0	5.6	4.7	4.0
4	8	4	32	5.4	5.4	5.4	5.7	6.3	7.2	7.8	8.0	7.8	7.2	6.3	5.7
2	8	4	64	4.0	4.0	4.0	4.0	4.0	4.2	5.0	6.0	6.3	6.0	5.0	4.2
4	8	4	64	5.6	5.6	5.6	5.9	6.5	7.4	8.0	8.4	8.0	7.4	6.5	5.9
2	8	99	32	6.6	6.6	6.6	6.6	6.6	7.1	7.9	9.2	9.6	9.2	7.9	7.1
4	8	99	32	8.8	8.8	8.8	9.2	10.0	11.0	11.7	12.1	11.7	11.0	10.0	9.2
2	8	99	64	6.8	6.8	6.8	6.8	6.8	7.2	8.1	9.3	9.7	9.3	8.1	7.2
4	8	99	64	8.8	8.8	8.8	9.2	10.0	11.1	11.7	12.1	11.7	11.1	10.0	9.2
2	16	4	32	4.7	4.7	4.7	4.7	4.7	5.1	6.0	6.9	6.8	6.9	6.0	5.1
4	16	4	32	7.0	7.0	7.0	7.5	8.2	9.5	10.4	10.7	10.4	9.5	8.2	7.5
2	16	4	64	4.9	4.9	4.9	4.9	4.9	5.3	6.3	7.6	8.0	7.6	6.3	5.3
4	16	4	64	7.2	7.2	7.2	7.6	8.5	9.7	10.5	10.9	10.5	9.7	8.5	7.6
2	16	99	32	8.1	8.1	8.1	8.1	8.1	8.6	9.7	11.2	11.8	11.2	9.7	8.6
4	16	99	32	11.0	11.0	11.0	11.5	12.4	13.8	14.8	15.2	14.8	13.8	12.4	11.5
2	16	99	64	8.1	8.1	8.1	8.1	8.1	8.6	9.7	11.3	11.8	11.3	9.7	8.6
4	16	99	64	10.9	10.9	10.9	11.3	12.3	13.7	14.6	15.1	14.6	13.7	12.3	11.3

Appendix D

Single-item Data

Model III

Summary of Data for 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with:

Optimal Policies (DP)

Power Approximation (PA)

Statistical Power Approximation

		page
Table A1	Average Total Cost	D1
A3	Period-End Inventory	D2
A4	Period-End Backlog as Proportion of Mean Demand	D3
A5	Frequency of Periods with Backlog	D4
A6	Replenishment Frequency	D5
A7	Estimated Bias of Forecast of Total Cost	D6
A8	Estimated Standard Deviation of Forecast of Total Cost	D7
A9	Values for (s_i, S_i)	D8 to D13
A10	Standard Deviations of (s_i, S_i) Values	D14 to D15

Note: For corresponding data in MacCormick (1974), see tables of the same number in Appendices A of those reports.

TABLE A1 AVERAGE TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

VALUES FOR RULES OTHER THAN THE OPTIMAL DP ARE % EXCESS OVER DP VALUE

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	24.4	2.6	7.5
4	8	4	32	27.1	3.5	10.7
2	16	4	32	34.1	6.2	9.2
4	16	4	32	38.0	4.1	9.2
2	8	99	32	40.1	5.5	16.6
4	8	99	32	46.2	7.0	23.9
2	16	99	32	54.3	7.5	18.6
4	16	99	32	62.7	7.8	18.7
2	8	4	64	31.0	5.1	9.9
4	8	4	64	33.3	5.4	10.7
2	16	4	64	43.4	2.5	4.9
4	16	4	64	46.8	3.9	9.1
2	8	99	64	47.1	8.7	19.4
4	8	99	64	52.8	4.9	17.6
2	16	99	64	64.4	5.4	13.1
4	16	99	64	72.4	8.0	21.4

TABLE A3 PERIOD-END INVENTORY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	11.1	12.1	13.1
4	8	4	32	13.3	13.8	15.6
2	16	4	32	15.7	13.9	14.9
4	16	4	32	19.0	20.6	20.8
2	8	99	32	27.3	31.3	33.5
4	8	99	32	33.2	37.9	41.3
2	16	99	32	36.0	36.3	38.8
4	16	99	32	44.1	52.1	52.6
2	8	4	64	14.1	14.9	16.1
4	8	4	64	16.1	16.3	17.3
2	16	4	64	19.2	19.7	20.7
4	16	4	64	22.0	21.8	24.3
2	8	99	64	30.6	36.5	39.3
4	8	99	64	36.6	39.4	42.7
2	16	99	64	41.1	45.4	47.3
4	16	99	64	49.5	54.2	58.4

TABLE A4 PERIOD-END BACKLOG AS PROPORTION OF MEAN DEMAND

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1635	0.1483	0.1566
4	8	4	32	0.2036	0.1921	0.2024
2	16	4	32	0.1117	0.1237	0.1278
4	16	4	32	0.1377	0.1127	0.1319
2	8	99	32	0.0057	0.0044	0.0072
4	8	99	32	0.0068	0.0050	0.0105
2	16	99	32	0.0035	0.0040	0.0065
4	16	99	32	0.0043	0.0026	0.0062
2	8	4	64	0.1806	0.1722	0.1780
4	8	4	64	0.2176	0.1998	0.2225
2	16	4	64	0.1191	0.1196	0.1209
4	16	4	64	0.1447	0.1555	0.1554
2	8	99	64	0.0056	0.0041	0.0069
4	8	99	64	0.0067	0.0053	0.0096
2	16	99	64	0.0035	0.0040	0.0060
4	16	99	64	0.0042	0.0049	0.0084

TABLE A5 FREQUENCY OF PERIODS WITH BACKLOG

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1862	0.1665	0.1677
4	8	4	32	0.1915	0.1751	0.1754
2	16	4	32	0.1918	0.2010	0.1987
4	16	4	32	0.1926	0.1599	0.1735
2	8	99	32	0.0091	0.0067	0.0099
4	8	99	32	0.0092	0.0066	0.0117
2	16	99	32	0.0093	0.0098	0.0134
4	16	99	32	0.0095	0.0055	0.0110
2	8	4	64	0.1892	0.1729	0.1694
4	8	4	64	0.1916	0.1728	0.1820
2	16	4	64	0.1930	0.1841	0.1810
4	16	4	64	0.1945	0.1932	0.1832
2	8	99	64	0.0090	0.0061	0.0090
4	8	99	64	0.0092	0.0070	0.0111
2	16	99	64	0.0091	0.0095	0.0125
4	16	99	64	0.0093	0.0094	0.0138

TABLE A6 REPLENISHMENT FREQUENCY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.252	0.256	0.255
4	8	4	32	0.228	0.253	0.250
2	16	4	32	0.350	0.448	0.443
4	16	4	32	0.318	0.367	0.383
2	8	99	32	0.261	0.237	0.235
4	8	99	32	0.237	0.237	0.237
2	16	99	32	0.398	0.490	0.484
4	16	99	32	0.370	0.358	0.376
2	8	4	64	0.174	0.190	0.192
4	8	4	64	0.160	0.193	0.194
2	16	4	64	0.260	0.269	0.268
4	16	4	64	0.243	0.264	0.264
2	8	99	64	0.188	0.179	0.179
4	8	99	64	0.170	0.185	0.184
2	16	99	64	0.277	0.251	0.250
4	16	99	64	0.252	0.255	0.254

TABLE A7 ESTIMATED BIAS OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)
COLUMN (1) % EXCESS OF MEAN ACTUAL COST OVER MEAN FORECAST COST
COLUMN (2) + : BIAS FOR O.C.: POSITIVE ; - : NEGATIVE ; # : SIGNIFICANTLY POSITIVE ; = : SIGNIFICANTLY NEGATIVE
SUBCOLUMNS: PERIOD-END INVENTORY, STOCKOUT QUANTITY, STOCKOUT FREQUENCY, REPLENISHMENT QUANTITY, REPLENISHMENT FREQUENCY, COST

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	(1) (24,24,24)	(2) (24,24,24)
2	8	4	32	1.4	+ # + - + #
4	8	4	32	3.3	# # + - - #
2	16	4	32	1.9	# # + - - #
4	16	4	32	3.5	# # + + + #
2	8	99	32	4.9	+ # # - + #
4	8	99	32	9.5	# # # + - #
2	16	99	32	8.1	+ # # - + #
4	16	99	32	10.7	# # # - + #
2	8	4	64	1.5	+ # + + + #
4	8	4	64	2.8	# # + + + #
2	16	4	64	1.2	+ + - - + #
4	16	4	64	4.2	# # + - - #
2	8	99	64	6.3	# # # + + #
4	8	99	64	8.6	# # # + + #
2	16	99	64	7.2	+ # # - - #
4	16	99	64	13.9	# # # + - #

TABLE A8 ESTIMATED STANDARD DEVIATION OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	(24,24,24)
2	8	4	32	3.7
4	8	4	32	4.9
2	16	4	32	4.0
4	16	4	32	6.2
2	8	99	32	8.9
4	8	99	32	13.0
2	16	99	32	13.4
4	16	99	32	12.8
2	8	4	64	4.6
4	8	4	64	5.5
2	16	4	64	5.0
4	16	4	64	5.4
2	8	99	64	9.5
4	8	99	64	12.0
2	16	99	64	11.3
4	16	99	64	18.5

TABLE A9 VALUES FOR LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	9	10	9	8	7	13	19	38	47	41	25	14
8	4	32	PA	9	9	9	9	9	14	24	39	44	39	24	14
			(24,24)	9.1	9.1	9.1	9.1	9.1	14.1	24.2	39.6	44.8	39.6	24.2	14.1
			DP	8	7	7	7	6	7	15	36	45	38	22	12
8	4	64	PA	6	6	6	6	6	11	20	36	40	35	20	11
			(24,24)	6.6	6.6	6.6	6.6	6.6	11.1	20.6	35.4	40.4	35.4	20.6	11.1
			DP	24	24	24	23	21	30	42	64	72	64	44	31
8	99	32	PA	24	24	24	24	24	31	44	64	70	64	44	31
			(24,24)	24.3	24.3	24.3	24.3	24.3	31.7	45.5	65.4	71.8	65.4	45.5	31.7
			DP	23	23	23	21	21	27	40	63	71	62	43	29
8	99	64	PA	22	22	22	22	22	29	42	61	67	61	42	29
			(24,24)	22.5	22.5	22.5	22.5	22.5	29.7	43.1	62.4	68.8	62.4	43.1	29.7
			DP	19	20	21	20	15	27	45	78	95	85	53	31
16	4	32	PA	20	20	20	20	20	30	50	82	92	82	50	30
			(24,24)	20.2	20.2	20.2	20.2	20.2	30.4	51.0	82.3	92.8	82.3	51.0	30.4
			DP	17	18	19	16	13	23	39	74	91	82	49	27
16	4	64	PA	17	17	17	17	17	26	46	76	86	76	46	26
			(24,24)	16.9	16.9	16.9	16.9	16.9	26.5	46.4	76.8	87.1	76.8	46.4	26.5
			DP	39	39	40	39	33	50	76	114	130	117	79	53
16	99	32	PA	39	39	39	39	39	53	78	115	127	115	78	53
			(24,24)	40.2	40.2	40.2	40.2	40.2	53.6	79.3	116.3	128.5	116.3	79.3	53.6
			DP	38	38	39	38	36	50	73	112	128	115	77	51
16	99	64	PA	37	37	37	37	37	50	75	111	123	111	75	50
			(24,24)	37.9	37.9	37.9	37.9	37.9	51.0	76.0	112.4	124.3	112.4	76.0	51.0

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	26	25	24	27	33	34	51	72	69	59	42	32
8	4	32	PA	25	25	25	25	25	33	48	69	75	69	48	33
			(24,24)	25.7	25.7	25.7	25.7	25.7	33.7	48.4	69.4	76.2	69.4	48.4	33.7
			DP	31	30	32	33	34	34	77	79	74	64	48	37
8	4	64	PA	30	30	30	30	30	39	55	77	84	77	55	39
			(24,24)	30.4	30.4	30.4	30.4	30.4	39.2	55.4	77.9	85.2	77.9	55.4	39.2
			DP	39	38	36	37	54	54	53	92	87	75	57	45
8	99	32	PA	40	40	40	40	40	50	68	94	101	94	68	50
			(24,24)	40.8	40.8	40.8	40.8	40.8	51.3	69.8	95.2	103.2	95.2	69.8	51.3
			DP	43	42	42	41	55	54	98	98	92	79	61	50
8	99	64	PA	46	46	46	46	46	57	77	103	111	103	77	57
			(24,24)	46.3	46.3	46.3	46.3	46.3	57.7	77.9	104.9	113.5	104.9	77.9	57.7
			DP	45	44	41	40	44	67	67	127	130	110	76	54
16	4	32	PA	43	43	43	43	43	57	83	102	113	102	83	57
			(24,24)	42.9	42.9	42.9	42.9	42.9	57.1	84.1	104.2	114.2	104.2	84.1	57.1
			DP	51	48	46	47	67	67	100	145	137	116	84	63
16	4	64	PA	49	49	49	49	49	64	93	133	146	133	93	64
			(24,24)	49.3	49.3	49.3	49.3	49.3	64.7	93.6	134.4	147.7	134.4	93.6	64.7
			DP	62	61	57	53	67	94	90	129	155	132	95	71
16	99	32	PA	62	62	62	62	62	80	111	126	139	126	111	80
			(24,24)	62.8	62.8	62.8	62.8	62.8	80.3	112.4	129.7	140.4	129.7	112.4	80.3
			DP	70	66	61	55	67	94	133	173	162	138	102	81
16	99	64	PA	69	69	69	69	69	88	122	168	183	168	122	88
			(24,24)	70.3	70.3	70.3	70.3	70.3	89.1	123.2	170.0	185.0	170.0	123.2	89.1

TABLE A9 VALUES FOR BIG S - LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(PIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	17	15	15	19	26	21	32	34	22	18	17	18
8	4	32	PA	16	16	16	16	16	19	24	30	31	30	24	19
			(24,24)	16.6	16.6	16.6	16.6	16.6	19.6	24.3	29.8	31.4	29.8	24.3	19.6
			DP	23	23	25	26	28	27	62	43	29	26	26	25
8	4	64	PA	24	24	24	24	24	28	35	42	44	42	35	28
			(24,24)	23.8	23.8	23.8	23.8	23.8	28.0	34.7	42.5	44.7	42.5	34.7	28.0
			DP	15	14	12	14	33	24	11	28	15	11	13	14
8	99	32	PA	16	16	16	16	16	19	24	30	31	30	24	19
			(24,24)	16.6	16.6	16.6	16.6	16.6	19.6	24.3	29.8	31.4	29.8	24.3	19.6
			DP	20	19	19	20	34	27	[illegible]	35	21	17	18	21
8	99	64	PA	24	24	24	24	24	28	[illegible]	42	44	42	35	28
			(24,24)	23.8	23.8	23.8	23.8	23.8	28.0	34.7	42.5	44.7	42.5	34.7	28.0
			DP	26	24	20	20	28	40	22	49	35	25	23	23
16	4	32	PA	23	23	23	23	23	27	33	20	21	20	33	27
			(24,24)	22.7	22.7	22.7	22.7	22.7	26.7	33.1	21.8	21.4	21.8	33.1	26.7
			DP	34	30	27	31	50	44	61	71	46	34	35	36
16	4	64	PA	32	32	32	32	32	38	47	57	60	57	47	38
			(24,24)	32.4	32.4	32.4	32.4	32.4	38.1	47.2	57.6	60.6	57.6	47.2	38.1
			DP	23	22	17	14	29	44	14	15	25	15	16	18
16	99	32	PA	23	23	23	23	23	27	33	11	12	11	33	27
			(24,24)	22.7	22.7	22.7	22.7	22.7	26.7	33.1	13.4	11.9	13.4	33.1	26.7
			DP	32	28	22	17	32	44	60	61	34	23	25	30
16	99	64	PA	32	32	32	32	32	38	47	57	60	57	47	38
			(24,24)	32.4	32.4	32.4	32.4	32.4	38.1	47.2	57.6	60.6	57.6	47.2	38.1

TABLE A9 VALUES FOR LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	18	16	15	20	28	46	62	68	61	49	33	23
8	4	32	PA	18	18	18	23	33	49	59	65	59	49	33	23
			(24,24)	18.1	18.1	18.1	23.2	33.8	49.6	60.3	65.6	60.3	49.6	33.8	23.2
			DP	15	15	15	16	22	44	60	66	59	47	31	20
8	4	64	PA	15	15	15	20	30	45	55	60	55	45	30	20
			(24,24)	15.2	15.2	15.2	20.1	30.2	45.5	55.8	61.0	55.8	45.5	30.2	20.1
			DP	35	35	33	40	52	73	90	96	88	74	55	42
8	99	32	PA	35	35	35	42	56	75	88	94	88	75	56	42
			(24,24)	36.1	36.1	36.1	43.2	56.8	76.5	89.2	95.6	89.2	76.5	56.8	43.2
			DP	33	32	32	39	50	72	89	94	86	72	53	40
8	99	64	PA	33	33	33	40	53	72	84	90	84	72	53	40
			(24,24)	34.0	34.0	34.0	40.9	54.1	73.2	85.7	91.9	85.7	73.2	54.1	40.9
			DP	39	37	33	43	62	94	122	138	125	102	69	48
16	4	32	PA	37	37	37	47	68	100	121	132	121	100	68	47
			(24,24)	37.5	37.5	37.5	48.0	69.1	101.0	122.4	133.0	122.4	101.0	69.1	48.0
			DP	35	33	29	38	57	88	119	134	122	98	66	45
16	4	64	PA	33	33	33	43	64	95	115	126	115	95	64	43
			(24,24)	33.7	33.7	33.7	43.9	64.4	95.6	116.5	127.0	116.5	95.6	64.4	43.9
			DP	61	59	59	70	95	133	160	175	162	136	99	73
16	99	32	PA	61	61	61	74	99	135	159	171	159	135	99	74
			(24,24)	61.5	61.5	61.5	74.4	99.7	136.6	160.8	172.7	160.8	136.6	99.7	74.4
			DP	59	58	56	68	93	129	159	173	160	134	97	72
16	99	64	PA	58	58	58	70	95	131	154	166	154	131	95	70
			(24,24)	58.6	58.6	58.6	71.3	96.0	132.2	156.0	167.8	156.0	132.2	96.0	71.3

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	35	37	41	43	59	86	87	86	80	68	52	41
8	4	32	PA	35	35	35	42	55	75	88	95	88	75	55	42
			(24,24)	35.2	35.2	35.2	42.4	56.2	76.1	89.0	95.4	89.0	76.1	56.2	42.4
			DP	42	42	43	43	91	91	91	91	84	73	57	47
8	4	64	PA	40	40	40	47	52	83	96	102	96	83	62	47
			(24,24)	39.8	39.8	39.8	47.5	52.3	83.3	96.8	103.5	96.8	83.3	62.3	47.5
			DP	50	50	50	64	84	110	110	108	100	86	68	56
8	99	32	PA	52	52	52	61	78	101	117	124	117	101	78	61
			(24,24)	53.3	53.3	53.3	62.3	79.2	103.0	118.0	125.4	118.0	103.0	79.2	62.3
			DP	53	66	66	65	115	115	113	111	103	90	72	59
8	99	64	PA	58	58	58	67	85	110	125	132	125	110	85	67
			(24,24)	58.7	58.7	58.7	68.3	86.1	111.0	126.8	134.5	126.8	111.0	86.1	68.3
			DP	60	61	62	83	116	138	164	164	151	127	95	73
16	4	32	PA	60	60	60	73	98	136	160	172	160	136	98	73
			(24,24)	60.9	60.9	60.9	74.1	99.7	137.0	159.0	165.4	159.0	137.0	99.7	74.1
			DP	66	65	83	83	116	170	171	169	157	134	101	78
16	4	64	PA	66	66	66	80	107	146	170	184	170	146	107	80
			(24,24)	67.3	67.3	67.3	81.1	108.0	146.8	172.2	184.7	172.2	146.8	108.0	81.1
			DP	79	75	87	113	110	149	196	194	179	152	116	93
16	99	32	PA	84	84	84	100	129	171	198	211	198	171	129	100
			(24,24)	84.9	84.9	84.9	100.5	130.3	172.5	196.4	201.6	196.4	172.5	130.3	100.5
			DP	84	91	88	114	152	204	202	198	184	158	123	99
16	99	64	PA	91	91	91	107	138	182	209	224	209	182	138	107
			(24,24)	92.2	92.2	92.2	108.5	139.6	183.5	211.8	225.6	211.8	183.5	139.6	108.5

TABLE A9 VALUES FOR BIG S - LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	17	21	26	23	31	40	25	18	19	19	19	18
8	4	32	PA	17	17	17	19	22	26	29	30	29	26	22	19
			(24,24)	17.2	17.2	17.2	19.1	22.4	26.5	28.7	29.8	28.7	26.5	22.4	19.1
			DP	27	27	28	27	69	47	31	25	25	26	26	27
8	4	64	PA	25	25	25	27	32	38	41	42	41	38	32	27
			(24,24)	24.7	24.7	24.7	27.4	32.1	37.8	41.1	42.6	41.1	37.8	32.1	27.4
			DP	15	15	17	24	32	37	20	12	12	12	13	14
8	99	32	PA	17	17	17	19	22	26	29	30	29	26	22	19
			(24,24)	17.2	17.2	17.2	19.1	22.4	26.5	28.7	29.8	28.7	26.5	22.4	19.1
			DP	20	34	34	26	65	43	24	17	17	18	19	19
8	99	64	PA	25	25	25	27	32	38	41	42	41	38	32	27
			(24,24)	24.7	24.7	24.7	27.4	32.1	37.8	41.1	42.6	41.1	37.8	32.1	27.4
			DP	22	24	29	40	54	44	42	26	26	25	26	25
16	4	32	PA	23	23	23	26	30	36	39	40	39	36	30	26
			(24,24)	23.5	23.5	23.5	26.1	30.6	35.9	36.6	32.4	36.6	35.9	30.6	26.1
			DP	31	32	54	45	59	82	52	35	35	36	35	33
16	4	64	PA	33	33	33	37	43	51	55	58	55	51	43	37
			(24,24)	33.6	33.6	33.6	37.3	43.6	51.3	55.7	57.8	55.7	51.3	43.6	37.3
			DP	18	16	28	43	15	16	36	19	17	16	17	20
16	99	32	PA	23	23	23	26	30	36	39	40	39	36	30	26
			(24,24)	23.5	23.5	23.5	26.1	30.6	35.9	35.6	28.9	35.6	35.9	30.6	26.1
			DP	25	33	32	46	59	75	43	25	24	24	26	27
16	99	64	PA	33	33	33	37	43	51	55	58	55	51	43	37
			(24,24)	33.6	33.6	33.6	37.3	43.6	51.3	55.7	57.8	55.7	51.3	43.6	37.3

TABLE A10 STANDARD DEVIATION OF LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III
STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	1.5	1.5	1.5	1.5	1.5	2.2	3.5	5.6	6.3	5.6	3.5	2.2
4	8	4	32	2.5	2.5	2.5	3.2	4.5	6.5	7.9	8.6	7.9	6.5	4.5	3.2
2	8	4	64	1.3	1.3	1.3	1.3	1.3	2.0	3.3	5.3	5.9	5.3	3.3	2.0
4	8	4	64	2.3	2.3	2.3	2.9	4.2	6.2	7.5	8.2	7.5	6.2	4.2	2.9
2	8	99	32	4.4	4.4	4.4	4.4	4.4	5.4	7.3	9.9	10.7	9.9	7.3	5.4
4	8	99	32	5.7	5.7	5.7	6.6	8.3	10.7	12.3	13.1	12.3	10.7	8.3	6.6
2	8	99	64	4.0	4.0	4.0	4.0	4.0	4.9	6.7	9.2	10.0	9.2	6.7	4.9
4	8	99	64	5.2	5.2	5.2	6.0	7.7	10.0	11.5	12.3	11.5	10.0	7.7	6.0
2	16	4	32	2.1	2.1	2.1	2.1	2.1	3.1	5.0	7.9	8.8	7.9	5.0	3.1
4	16	4	32	3.5	3.5	3.5	4.5	6.4	9.2	11.1	12.0	11.1	9.2	6.4	4.5
2	16	4	64	1.9	1.9	1.9	1.9	1.9	2.8	4.7	7.5	8.5	7.5	4.7	2.8
4	16	4	64	3.4	3.4	3.4	4.2	6.1	8.9	10.7	11.7	10.7	8.9	6.1	4.2
2	16	99	32	5.3	5.3	5.3	5.3	5.3	6.6	8.9	12.3	13.4	12.3	8.9	6.6
4	16	99	32	7.1	7.1	7.1	8.2	10.4	13.6	15.6	16.7	15.6	13.6	10.4	8.2
2	16	99	64	4.8	4.8	4.8	4.8	4.8	6.0	8.3	11.5	12.5	11.5	8.3	6.0
4	16	99	64	6.5	6.5	6.5	7.6	9.8	12.8	14.8	15.9	14.8	12.8	9.8	7.6

TABLE A10 STANDARD DEVIATION OF BIG S

EGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL III
TATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	2.6	2.6	2.6	2.6	2.6	3.5	5.1	7.5	8.3	7.5	5.1	3.5
4	8	4	32	3.6	3.6	3.6	4.4	6.0	8.2	9.7	10.4	9.7	8.2	6.0	4.4
2	8	4	64	2.7	2.7	2.7	2.7	2.7	3.6	5.4	7.9	8.7	7.9	5.4	3.6
4	8	4	64	3.8	3.8	3.8	4.6	6.2	8.5	10.0	10.7	10.0	8.5	6.2	4.6
2	8	99	32	5.4	5.4	5.4	5.4	5.4	6.7	8.8	11.8	12.7	11.8	8.8	6.7
4	8	99	32	6.7	6.7	6.7	7.8	9.6	12.3	14.1	15.0	14.1	12.3	9.6	7.8
2	8	99	64	5.4	5.4	5.4	5.4	5.4	6.6	8.9	11.9	12.8	11.9	8.9	6.6
4	8	99	64	6.7	6.7	6.7	7.7	9.7	12.3	14.1	14.9	14.1	12.3	9.7	7.7
2	16	4	32	3.2	3.2	3.2	3.2	3.2	4.3	6.5	8.5	9.9	8.5	6.5	4.3
4	16	4	32	4.6	4.6	4.6	5.7	7.8	10.7	10.7	10.4	10.7	10.7	7.8	5.7
2	16	4	64	3.3	3.3	3.3	3.3	3.3	4.5	6.7	10.0	11.1	10.0	6.7	4.5
4	16	4	64	4.9	4.9	4.9	5.9	8.0	11.1	13.1	14.1	13.1	11.1	8.0	5.9
2	16	99	32	6.3	6.3	6.3	6.3	6.3	7.9	10.5	13.0	13.4	13.0	10.5	7.9
4	16	99	32	8.1	8.1	8.1	9.4	11.9	15.4	16.2	17.0	16.2	15.4	11.9	9.4
2	16	99	64	6.3	6.3	6.3	6.3	6.3	7.8	10.5	14.2	15.4	14.2	10.5	7.8
4	16	99	64	8.0	8.0	8.0	9.3	11.8	15.2	17.4	18.6	17.4	15.2	11.8	9.3

Appendix E

Single-item Data

Model IV

Summary of Data for 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with:

Optimal Policies (DP)

Power Approximation (PA)

Statistical Power Approximation

		page
Table A1	Average Total Cost	E1
A3	Period-End Inventory	E2
A4	Period-End Backlog as Proportion of Mean Demand	E3
A5	Frequency of Periods with Backlog	E4
A6	Replenishment Frequency	E5
A7	Estimated Bias of Forecast of Total Cost	E6
A8	Estimated Standard Deviation of Forecast of Total Cost	E7
A9	Values for (s_i, S_i)	E8 to E13
A10	Standard Deviations of (s_i, S_i) Values	E14 to E15

Note: For corresponding data in MacCormick (1974), see tables of the same number in Appendices A of those reports.

TABLE A1 AVERAGE TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

VALUES FOR RULES OTHER THAN THE OPTIMAL DP ARE % EXCESS OVER DP VALUE

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	25.0	1.5	5.6
4	8	4	32	27.8	2.2	9.4
2	16	4	32	34.9	0.9	4.1
4	16	4	32	38.8	1.3	7.2
2	8	99	32	41.1	2.7	13.8
4	8	99	32	47.2	2.9	17.1
2	16	99	32	55.8	2.4	11.6
4	16	99	32	64.2	3.0	16.0
2	8	4	64	32.0	2.2	5.3
4	8	4	64	34.4	2.9	8.0
2	16	4	64	45.0	1.7	4.0
4	16	4	64	48.4	2.4	7.7
2	8	99	64	48.6	3.7	11.5
4	8	99	64	54.3	4.0	15.2
2	16	99	64	66.9	3.0	9.9
4	16	99	64	74.8	3.2	12.7

TABLE A3 PERIOD-END INVENTORY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	11.3	11.6	12.6
4	8	4	32	13.5	13.9	15.4
2	16	4	32	15.7	16.5	16.9
4	16	4	32	18.6	19.1	20.9
2	8	99	32	27.8	30.4	32.6
4	8	99	32	33.2	36.4	39.6
2	16	99	32	37.9	40.6	42.1
4	16	99	32	45.7	48.7	51.7
2	8	4	64	13.9	14.0	14.9
4	8	4	64	15.8	15.4	17.0
2	16	4	64	19.6	19.7	21.1
4	16	4	64	22.4	22.6	24.7
2	8	99	64	30.9	33.8	35.9
4	8	99	64	36.3	39.0	41.9
2	16	99	64	42.1	45.3	48.2
4	16	99	64	49.0	53.2	56.2

TABLE A4 PERIOD-END BACKLOG AS PROPORTION OF MEAN DEMAND

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1736	0.1628	0.1633
4	8	4	32	0.2071	0.1892	0.2028
2	16	4	32	0.1133	0.1088	0.1136
4	16	4	32	0.1390	0.1361	0.1438
2	8	99	32	0.0059	0.0044	0.0074
4	8	99	32	0.0066	0.0051	0.0096
2	16	99	32	0.0036	0.0033	0.0052
4	16	99	32	0.0043	0.0040	0.0074
2	8	4	64	0.1824	0.1881	0.1892
4	8	4	64	0.2206	0.2279	0.2304
2	16	4	64	0.1260	0.1209	0.1159
4	16	4	64	0.1539	0.1379	0.1433
2	8	99	64	0.0057	0.0054	0.0076
4	8	99	64	0.0068	0.0065	0.0106
2	16	99	64	0.0037	0.0032	0.0047
4	16	99	64	0.0044	0.0041	0.0067

TABLE A5 FREQUENCY OF PERIODS WITH BACKLOG

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.1912	0.1773	0.1718
4	8	4	32	0.1905	0.1746	0.1757
2	16	4	32	0.1895	0.1795	0.1806
4	16	4	32	0.1930	0.1848	0.1840
2	8	99	32	0.0093	0.0068	0.0103
4	8	99	32	0.0089	0.0068	0.0112
2	16	99	32	0.0091	0.0082	0.0114
4	16	99	32	0.0093	0.0083	0.0133
2	8	4	64	0.1882	0.1856	0.1829
4	8	4	64	0.1913	0.1916	0.1856
2	16	4	64	0.1916	0.1812	0.1709
4	16	4	64	0.1954	0.1768	0.1733
2	8	99	64	0.0089	0.0080	0.0104
4	8	99	64	0.0092	0.0083	0.0121
2	16	99	64	0.0092	0.0077	0.0103
4	16	99	64	0.0094	0.0083	0.0120

TABLE A6 REPLENISHMENT FREQUENCY

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION)

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	DP	PA	(24,24)
2	8	4	32	0.255	0.268	0.269
4	8	4	32	0.240	0.266	0.267
2	16	4	32	0.372	0.367	0.381
4	16	4	32	0.351	0.358	0.359
2	8	99	32	0.272	0.261	0.260
4	8	99	32	0.276	0.255	0.254
2	16	99	32	0.385	0.351	0.373
4	16	99	32	0.365	0.348	0.347
2	8	4	64	0.192	0.199	0.200
4	8	4	64	0.180	0.199	0.200
2	16	4	64	0.271	0.285	0.285
4	16	4	64	0.253	0.284	0.284
2	8	99	64	0.207	0.193	0.192
4	8	99	64	0.197	0.193	0.192
2	16	99	64	0.298	0.281	0.278
4	16	99	64	0.294	0.273	0.273

TABLE A7 ESTIMATED BIAS OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)
COLUMN (1) % EXCESS OF MEAN ACTUAL COST OVER MEAN FORECAST COST
COLUMN (2) + : BIAS FOR O.C.: POSITIVE ; - : NEGATIVE ; # : SIGNIFICANTLY POSITIVE ; = : SIGNIFICANTLY NEGATIVE
SUBCOLUMNS: PERIOD-END INVENTORY, STOCKOUT QUANTITY, STOCKOUT FREQUENCY, REPLENISHMENT QUANTITY, REPLENISHMENT FREQUENCY, COST

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	(1) (24,24,24)	(2) (24,24,24)
2	8	4	32	1.3	# # + - + #
4	8	4	32	3.0	# # + - - #
2	16	4	32	1.2	# + + + - #
4	16	4	32	3.6	# # + + - #
2	8	99	32	6.0	# # # + + #
4	8	99	32	8.1	# # # + - #
2	16	99	32	6.5	# # # + + #
4	16	99	32	11.8	# = # - - #
2	8	4	64	1.4	# # + + - #
4	8	4	64	2.6	# # + + + #
2	16	4	64	1.2	# + - + + #
4	16	4	64	3.4	# # + + + #
2	8	99	64	4.8	+ # # + + #
4	8	99	64	7.8	# # # - - #
2	16	99	64	6.1	# # # - - #
4	16	99	64	9.9	# # # + + #

TABLE A8 ESTIMATED STANDARD DEVIATION OF FORECAST OF TOTAL COST

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y,Z) = (REVISION INTERVAL, NO. OF PERIODS DEMAND DATA USED FOR REVISION, NO. OF PERIODS DEMAND DATA USED TO FORECAST)

LEADTIME	MEAN	C(OUT)/C(IN)	C(FIX)/C(IN)	(24,24,24)
2	8	4	32	3.6
4	8	4	32	5.2
2	16	4	32	4.3
4	16	4	32	6.2
2	8	99	32	7.5
4	8	99	32	10.2
2	16	99	32	11.2
4	16	99	32	11.9
2	8	4	64	4.2
4	8	4	64	5.1
2	16	4	64	4.4
4	16	4	64	6.2
2	8	99	64	9.6
4	8	99	64	11.6
2	16	99	64	14.7
4	16	99	64	13.2

TABLE A9 VALUES FOR LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	11	6	5	9	15	21	27	33	34	31	25	18
8	4	32	PA	11	7	7	11	17	23	29	33	33	29	23	17
			(24,24)	11.4	7.4	7.4	11.4	17.3	23.4	29.6	33.8	33.8	29.6	23.4	17.3
			DP	9	4	3	7	13	17	24	30	32	29	23	16
8	4	64	PA	8	5	5	8	14	20	25	29	29	25	20	14
			(24,24)	8.6	5.1	5.1	8.6	14.2	19.9	25.8	29.8	29.8	25.8	19.9	14.2
			DP	26	20	19	25	34	42	50	57	58	52	44	35
8	99	32	PA	27	21	21	27	35	43	51	57	57	51	43	35
			(24,24)	27.6	21.6	21.6	27.6	36.3	44.6	52.7	58.0	58.0	52.7	44.6	36.3
			DP	25	18	18	24	33	40	49	55	56	51	43	34
8	99	64	PA	25	19	19	25	33	41	49	54	54	49	41	33
			(24,24)	25.8	20.0	20.0	25.8	34.2	42.2	50.0	55.2	55.2	50.0	42.2	34.2
			DP	25	16	14	22	34	46	59	69	70	63	52	39
16	4	32	PA	24	16	16	24	37	49	61	70	70	61	49	37
			(24,24)	24.8	16.7	16.7	24.8	37.1	49.6	62.0	70.5	70.5	62.0	49.6	37.1
			DP	23	12	10	19	30	41	54	64	66	60	49	36
16	4	64	PA	21	13	13	21	33	44	56	65	65	56	44	33
			(24,24)	21.2	13.6	13.6	21.2	33.0	45.0	57.1	65.3	65.3	57.1	45.0	33.0
			DP	46	33	33	44	60	75	90	101	102	93	78	62
16	99	32	PA	45	35	35	45	61	76	91	101	101	91	76	61
			(24,24)	46.4	35.5	35.5	46.4	62.3	77.6	92.7	102.6	102.6	92.7	77.6	62.3
			DP	44	32	31	42	57	73	88	99	100	91	76	60
16	99	64	PA	43	33	33	43	58	73	88	97	97	88	73	58
			(24,24)	44.0	33.4	33.4	44.0	59.4	74.4	89.1	98.9	98.9	89.1	74.4	59.4

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	27	25	27	34	42	50	59	63	59	51	41	33
8	4	32	PA	29	22	22	29	38	47	55	61	61	55	47	38
			(24,24)	29.4	22.7	22.7	29.4	38.6	47.5	56.0	61.7	61.7	56.0	47.5	38.6
			DP	33	32	35	41	49	61	71	70	65	56	46	37
8	4	64	PA	34	27	27	34	44	54	62	69	69	62	54	44
			(24,24)	34.4	27.1	27.1	34.4	44.6	54.3	63.5	69.6	69.6	63.5	54.3	44.6
			DP	39	36	42	51	60	66	80	81	76	67	56	46
8	99	32	PA	45	36	36	45	56	67	77	85	85	77	67	56
			(24,24)	45.6	36.9	36.9	45.6	57.6	68.6	79.0	85.8	85.8	79.0	68.6	57.6
			DP	43	44	53	56	67	86	91	88	81	70	59	50
8	99	64	PA	51	41	41	51	63	75	86	94	94	86	75	63
			(24,24)	51.6	42.1	42.1	51.6	64.7	76.6	87.8	95.0	95.0	87.8	76.6	64.7
			DP	46	39	38	50	67	84	99	107	106	94	76	59
16	4	32	PA	48	37	37	48	66	82	97	108	108	97	82	66
			(24,24)	49.5	37.7	37.7	49.5	66.1	82.3	97.0	102.4	102.4	97.0	82.3	66.1
			DP	51	48	51	66	83	99	112	121	118	101	81	64
16	4	64	PA	56	43	43	56	74	90	107	119	119	107	90	74
			(24,24)	56.4	43.7	43.7	56.4	74.4	91.6	108.4	119.3	119.3	108.4	91.6	74.4
			DP	61	55	56	73	93	113	128	136	131	115	95	76
16	99	32	PA	69	56	56	69	90	109	127	139	139	127	109	90
			(24,24)	71.1	56.5	56.5	71.1	91.3	110.4	127.3	132.0	132.0	127.3	110.4	91.3
			DP	68	62	75	94	94	115	136	151	141	122	100	81
16	99	64	PA	78	63	63	78	99	119	139	151	151	139	119	99
			(24,24)	79.2	63.5	63.5	79.2	100.8	121.1	140.4	152.9	152.9	140.4	121.1	100.8

TABLE A9 VALUES FOR BIG S - LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV
REPLENISHMENT LEADTIME = 2

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	16	19	22	25	27	29	32	30	25	20	16	15
8	4	32	PA	18	15	15	18	21	24	26	28	28	26	24	21
			(24,24)	18.0	15.3	15.3	18.0	21.3	24.0	26.4	27.9	27.9	26.4	24.0	21.3
			DP	24	28	32	34	36	44	47	40	33	27	23	21
8	4	64	PA	26	22	22	26	30	34	37	40	40	37	34	30
			(24,24)	25.8	22.0	22.0	25.8	30.5	34.4	37.8	39.8	39.8	37.8	34.4	30.5
			DP	13	16	23	26	26	24	30	24	18	15	12	11
8	99	32	PA	18	15	15	18	21	24	26	28	28	26	24	21
			(24,24)	18.0	15.3	15.3	18.0	21.3	24.0	26.4	27.9	27.9	26.4	24.0	21.3
			DP	18	26	35	32	34	46	42	33	25	19	16	16
8	99	64	PA	26	22	22	26	30	34	37	40	40	37	34	30
			(24,24)	25.8	22.0	22.0	25.8	30.5	34.4	37.8	39.8	39.8	37.8	34.4	30.5
			DP	21	23	24	28	33	38	40	38	36	31	24	20
16	4	32	PA	24	21	21	24	29	33	36	38	38	36	33	29
			(24,24)	24.7	21.0	21.0	24.7	29.1	32.8	35.0	31.9	31.9	35.0	32.8	29.1
			DP	28	36	41	47	53	58	58	57	52	41	32	28
16	4	64	PA	35	30	30	35	41	46	51	54	54	51	46	41
			(24,24)	35.2	30.1	30.1	35.2	41.5	46.7	51.3	54.0	54.0	51.3	46.7	41.5
			DP	15	22	23	29	33	38	38	35	29	22	17	14
16	99	32	PA	24	21	21	24	29	33	36	38	38	36	33	29
			(24,24)	24.7	21.0	21.0	24.7	29.1	32.8	34.6	29.4	29.4	34.6	32.8	29.1
			DP	24	30	44	52	37	42	48	52	41	31	24	21
16	99	64	PA	35	30	30	35	41	46	51	54	54	51	46	41
			(24,24)	35.2	30.1	30.1	35.2	41.5	46.7	51.3	54.0	54.0	51.3	46.7	41.5

TABLE A9 VALUES FOR LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	18	17	21	29	39	49	56	57	53	43	32	23
8	4	32	PA	19	19	24	32	42	51	55	55	51	42	32	24
			(24,24)	20.0	20.0	24.2	32.6	43.3	51.7	56.0	56.0	51.7	43.3	32.6	24.2
			DP	15	15	19	24	35	46	53	55	50	41	30	20
8	4	64	PA	17	17	20	28	38	46	51	51	46	38	28	20
			(24,24)	17.0	17.0	20.9	29.1	39.3	47.5	51.7	51.7	47.5	39.3	29.1	20.9
			DP	37	36	41	52	65	76	83	84	78	67	54	43
8	99	32	PA	38	38	43	54	67	77	82	82	77	67	54	43
			(24,24)	38.9	38.9	44.5	55.4	68.7	79.1	84.3	84.3	79.1	68.7	55.4	44.5
			DP	35	34	40	49	63	75	82	82	76	65	52	41
8	99	64	PA	36	36	41	51	64	74	79	79	74	64	51	41
			(24,24)	36.6	36.6	42.1	52.7	65.7	75.8	80.8	80.8	75.8	65.7	52.7	42.1
			DP	39	37	45	62	83	101	111	115	107	90	67	49
16	4	32	PA	41	41	49	66	87	104	112	112	104	87	66	49
			(24,24)	41.3	41.3	49.8	66.9	88.2	105.3	113.8	113.8	105.3	88.2	66.9	49.8
			DP	34	34	40	56	78	95	107	111	104	86	64	45
16	4	64	PA	37	37	45	61	82	98	107	107	98	82	61	45
			(24,24)	37.4	37.4	45.7	62.1	83.0	99.7	108.1	108.1	99.7	83.0	62.1	45.7
			DP	64	63	73	93	118	138	149	151	142	121	96	75
16	99	32	PA	65	65	75	96	120	139	149	149	139	120	96	75
			(24,24)	66.5	66.5	76.9	97.2	122.1	141.7	151.4	151.4	141.7	122.1	97.2	76.9
			DP	62	60	71	90	115	135	147	150	140	119	94	73
16	99	64	PA	62	62	72	92	116	135	144	144	135	116	92	72
			(24,24)	63.4	63.4	73.8	93.5	118.0	137.2	146.8	146.8	137.2	118.0	93.5	73.6

TABLE A9 VALUES FOR BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	40	41	49	60	72	83	83	79	71	61	50	43
8	4	32	PA	37	37	43	54	67	78	83	83	78	67	54	43
			(24,24)	37.9	37.9	43.6	54.7	68.2	78.7	83.9	83.9	78.7	68.2	54.7	43.6
			DP	49	50	55	65	88	90	88	83	75	65	55	50
8	4	64	PA	43	43	48	59	73	84	90	90	84	73	59	48
			(24,24)	42.7	42.7	48.8	60.7	74.9	86.0	91.4	91.4	86.0	74.9	60.7	48.8
			DP	56	61	61	75	91	106	105	99	91	79	67	59
8	99	32	PA	56	56	62	76	92	104	110	110	104	92	76	62
			(24,24)	56.9	56.9	63.9	77.5	93.6	106.1	112.2	112.2	106.1	93.6	77.5	63.9
			DP	66	64	75	87	112	112	109	103	94	82	71	65
8	99	64	PA	62	62	69	82	99	112	118	118	112	99	82	69
			(24,24)	62.3	62.3	69.9	84.3	101.3	114.3	120.6	120.6	114.3	101.3	84.3	69.9
			DP	68	66	78	100	124	141	153	148	133	112	90	75
16	4	32	PA	65	65	75	96	121	140	150	150	140	121	96	75
			(24,24)	65.8	65.8	76.4	97.0	122.2	141.9	151.3	151.3	141.9	122.2	97.0	76.4
			DP	77	81	97	119	137	160	164	154	139	117	96	83
16	4	64	PA	72	72	83	104	130	150	161	161	150	130	104	83
			(24,24)	72.5	72.5	83.6	105.1	131.4	152.0	162.2	162.2	152.0	131.4	105.1	83.6
			DP	86	90	107	133	157	173	184	176	160	137	113	96
16	99	32	PA	89	89	101	126	154	175	187	187	175	154	126	101
			(24,24)	91.0	91.0	103.4	127.4	156.1	178.3	188.7	188.7	178.3	156.1	127.4	103.4
			DP	99	112	108	133	159	195	193	182	165	141	118	103
16	99	64	PA	97	97	110	135	164	187	198	198	187	164	135	110
			(24,24)	98.4	98.4	111.5	136.5	166.4	189.5	200.9	200.9	189.5	166.4	136.5	111.5

TABLE A9 VALUES FOR BIG S - LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV
REPLENISHMENT LEADTIME = 4

STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)		PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
			DP	22	24	28	31	33	34	27	22	18	18	18	20
8	4	32	PA	18	18	19	22	25	27	28	28	27	25	22	19
			(24,24)	17.9	17.9	19.4	22.1	24.9	27.0	27.9	27.9	27.0	24.9	22.1	19.4
			DP	34	35	36	41	53	44	35	28	25	24	25	30
8	4	64	PA	26	26	28	31	35	38	39	39	38	35	31	28
			(24,24)	25.7	25.7	27.9	31.6	35.6	38.5	39.8	39.8	38.5	35.6	31.6	27.9
			DP	19	25	20	23	26	30	22	15	13	12	13	16
8	99	32	PA	18	18	19	22	25	27	28	28	27	25	22	19
			(24,24)	17.9	17.9	19.4	22.1	24.9	27.0	27.9	27.9	27.0	24.9	22.1	19.4
			DP	31	30	35	38	49	37	27	21	18	17	19	24
8	99	64	PA	26	26	28	31	35	38	39	39	38	35	31	28
			(24,24)	25.7	25.7	27.9	31.6	35.6	38.5	39.8	39.8	38.5	35.6	31.6	27.9
			DP	29	29	33	38	41	40	42	33	26	22	23	26
16	4	32	PA	24	24	26	30	34	36	38	38	36	34	30	26
			(24,24)	24.5	24.5	26.5	30.2	34.0	36.6	37.4	37.4	36.6	34.0	30.2	26.5
			DP	43	47	57	63	59	65	57	43	35	31	32	38
16	4	64	PA	35	35	38	43	48	52	54	54	52	48	43	38
			(24,24)	35.0	35.0	37.9	43.0	48.4	52.3	54.1	54.1	52.3	48.4	43.0	37.9
			DP	22	27	34	40	39	35	35	25	18	16	17	21
16	99	32	PA	24	24	26	30	34	36	38	38	36	34	30	26
			(24,24)	24.5	24.5	26.5	30.1	34.0	36.6	37.3	37.3	36.6	34.0	30.1	26.5
			DP	37	52	37	43	44	60	46	32	25	22	24	30
16	99	64	PA	35	35	38	43	48	52	54	54	52	48	43	38
			(24,24)	35.0	35.0	37.9	43.0	48.4	52.3	54.1	54.1	52.3	48.4	43.0	37.9

TABLE A10 STANDARD DEVIATION OF LITTLE S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV
STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	1.7	1.2	1.2	1.7	2.5	3.3	4.2	4.7	4.7	4.2	3.3	2.5
4	8	4	32	2.8	2.8	3.4	4.5	5.9	6.9	7.5	7.5	6.9	5.9	4.5	3.4
2	8	4	64	1.5	1.0	1.0	1.5	2.3	3.1	3.8	4.3	4.3	3.8	3.1	2.3
4	8	4	64	2.5	2.5	3.1	4.2	5.5	6.6	7.1	7.1	6.6	5.5	4.2	3.1
2	8	99	32	4.7	3.9	3.9	4.7	5.9	7.0	8.0	8.7	8.7	8.0	7.0	5.9
4	8	99	32	6.2	6.2	6.8	8.3	9.9	11.2	11.8	11.8	11.2	9.9	8.3	6.8
2	8	99	64	4.2	3.5	3.5	4.2	5.4	6.4	7.4	8.0	8.0	7.4	6.4	5.4
4	8	99	64	5.6	5.6	6.3	7.6	9.2	10.5	11.1	11.1	10.5	9.2	7.6	6.3
2	16	4	32	2.5	1.8	1.8	2.5	3.6	4.8	5.9	6.7	6.7	5.9	4.8	3.6
4	16	4	32	4.0	4.0	4.7	6.3	8.2	9.7	10.5	10.5	9.7	8.2	6.3	4.7
2	16	4	64	2.3	1.6	1.6	2.3	3.4	4.5	5.6	6.4	6.4	5.6	4.5	3.4
4	16	4	64	3.7	3.7	4.5	6.0	7.9	9.4	10.1	10.1	9.4	7.9	6.0	4.5
2	16	99	32	5.8	4.7	4.7	5.8	7.2	8.7	10.0	10.9	10.9	10.0	8.7	7.2
4	16	99	32	7.6	7.6	8.6	10.4	12.5	14.3	15.1	15.1	14.3	12.5	10.4	8.6
2	16	99	64	5.3	4.3	4.3	5.3	6.7	8.0	9.4	10.2	10.2	9.4	8.0	6.7
4	16	99	64	7.0	7.0	7.9	9.7	11.8	13.4	14.3	14.3	13.4	11.8	9.7	7.9

TABLE A10 STANDARD DEVIATION OF BIG S

NEGATIVE BINOMIAL DISTRIBUTION FOR DEMAND, MODEL IV
STATISTICAL POLICIES COMPUTED USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES
(X,Y) : X = REVISION INTERVAL ; Y = # PERIODS DATA USED TO REVISE PARAMETERS

LEADTIME	MEAN	C(OUT) /C(IN)	C(FIX) /C(IN)	PERIOD IN CYCLE 1	2	3	4	5	6	7	8	9	10	11	12
2	8	4	32	2.9	2.2	2.2	2.9	3.9	4.9	5.8	6.5	6.5	5.8	4.9	3.9
4	8	4	32	4.0	4.0	4.6	5.9	7.5	8.6	9.2	9.2	8.6	7.5	5.9	4.6
2	8	4	64	3.1	2.4	2.4	3.1	4.2	5.2	6.2	6.8	6.8	6.2	5.2	4.2
4	8	4	64	4.1	4.1	4.8	6.1	7.7	8.9	9.5	9.5	8.9	7.7	6.1	4.8
2	8	99	32	5.8	4.8	4.8	5.8	7.3	8.5	9.7	10.5	10.5	9.7	8.5	7.3
4	8	99	32	7.2	7.2	8.0	9.6	11.5	12.9	13.6	13.6	12.9	11.5	9.6	8.0
2	8	99	64	5.9	4.8	4.8	5.9	7.3	8.6	9.9	10.6	10.6	9.9	8.6	7.3
4	8	99	64	7.2	7.2	8.0	9.6	11.5	12.9	13.6	13.6	12.9	11.5	9.6	8.0
2	16	4	32	3.7	2.8	2.8	3.7	5.0	6.3	6.9	7.9	7.9	6.9	6.3	5.0
4	16	4	32	5.1	5.1	6.0	7.6	9.7	11.2	11.6	11.6	11.2	9.7	7.6	6.0
2	16	4	64	3.8	2.9	2.9	3.8	5.2	6.5	7.8	8.7	8.7	7.8	6.5	5.2
4	16	4	64	5.2	5.2	6.1	7.9	10.0	11.6	12.4	12.4	11.6	10.0	7.9	6.1
2	16	99	32	7.0	5.7	5.7	7.0	8.6	10.2	11.8	14.6	14.6	11.8	10.2	8.6
4	16	99	32	8.8	8.8	9.8	11.8	14.1	16.0	16.5	16.5	16.0	14.1	11.8	9.8
2	16	99	64	6.9	5.6	5.6	6.9	8.6	10.2	11.8	12.8	12.8	11.8	10.2	8.6
4	16	99	64	8.7	8.7	9.6	11.7	14.1	15.9	16.8	16.8	15.9	14.1	11.7	9.6

Appendix F

Multi-item Data for the Power Approximation

Stationary Model

System of 16 Items with Negative Binomial Demand Distributions

(Variance/Mean = 3) Controlled Optimally with Full Information.

		page
Table F1	Sources of Expected Total Cost	F1
F3	Sources of Aggregate Period-End Inventory	F2
F4	Sources of Aggregate Backlog Cost	F3
F5	Sources of Aggregate Replenishment Cost	F4
F6	Backlog Frequency	F5
F7	Weighted Proportion of Demand Backlogged	F6
F8	Replenishment Frequency	F7

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendix C.

Table F1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 759.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.6	61.4	45.2	54.8	47.4	52.6	41.8	58.2
MEAN									
8		16.0	25.8	18.9	22.9	19.8	22.0		
16		22.6	35.6	26.3	31.9	27.6	30.6		
LEADTIME									
2		18.5	28.9	21.2	26.1				
4		20.1	32.5	24.0	28.7				
C(FIX)/C(IN)									
32		17.0	28.2						
64		21.6	33.2						
LEADTIME	C(FIX)/C(IN)								
2	32	8.1	13.2						
2	64	10.4	15.7						
4	32	8.9	15.0						
4	64	11.2	17.5						

Table F3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 439.3 PERCENT OF TOTAL COST= 57.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		30.0	70.0	46.9	53.1	46.0	54.0	42.1	57.9
MEAN									
8		12.6	29.6	19.9	22.3	19.4	22.7		
16		17.4	40.4	27.0	30.9	26.6	31.3		
LEADTIME									
2		13.9	32.1	21.3	24.7				
4		16.1	37.9	25.6	28.5				
C(FIX)/C(IN)									
32		13.7	33.2						
64		16.3	36.8						
LEADTIME	C(FIX)/C(IN)								
2	32	6.2	15.0						
2	64	7.6	17.0						
4	32	7.4	18.1						
4	64	8.7	19.8						

Table F4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, OPTIMAL CONTROL (DP)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 109.2 PERCENT OF TOTAL COST= 14.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		56.0	44.0	48.7	51.3	46.0	54.0	41.9	58.1
MEAN									
8		23.0	18.9	20.3	21.6	19.1	22.8		
16		33.0	25.1	28.4	29.7	26.9	31.2		
LEADTIME									
2		25.8	20.2	22.4	23.6				
4		30.2	23.8	26.3	27.7				
C(FIX)/C(IN)									
32		26.8	21.9						
64		29.2	22.1						
LEADTIME	C(FIX)/C(IN)								
2	32	12.2	10.2						
2	64	13.6	10.0						
4	32	14.6	11.7						
4	64	15.6	12.1						

Table F5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 211.0 PERCENT OF TOTAL COST= 27.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		47.6	52.4	40.0	60.0	51.0	49.0	41.1	58.9
MEAN									
	8	19.7	21.5	16.4	24.8	21.0	20.1		
	16	27.9	30.9	23.6	35.2	30.0	28.8		
LEADTIME									
	2	24.4	26.6	20.5	30.5				
	4	23.2	25.8	19.4	29.5				
C(FIX)/C(IN)									
	32	19.0	21.0						
	64	28.6	31.4						

LEADTIME	C(FIX)/C(IN)		
2	32	9.8	10.7
2	64	14.6	15.9
4	32	9.2	10.3
4	64	14.0	15.5

Table F6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, OPTIMAL CONTROL(DP)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1005

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.1916	0.0095	0.1000	0.1010	0.1010	0.1000	0.0984	0.1026
	8	0.1875	0.0092	0.0971	0.0996	0.0994	0.0978		
	16	0.1956	0.0097	0.1028	0.1024	0.1026	0.1027		
LEADTIME									
	2	0.1926	0.0094	0.1001	0.1019				
	4	0.1906	0.0095	0.0999	0.1001				
C(FIX)/C(IN)									
	32	0.1905	0.0095						
	64	0.1927	0.0094						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1905	0.0096
2	64	0.1946	0.0092
4	32	0.1904	0.0094
4	64	0.1907	0.0096

Table F7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, OPTIMAL CONTROL(DP)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0110

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.1593	0.0051	0.0108	0.0113	0.0102	0.0119	0.0139	0.0096
	8	0.1967	0.0065	0.0135	0.0143	0.0127	0.0151		
	16	0.1406	0.0043	0.0094	0.0098	0.0089	0.0103		
LEADTIME									
	2	0.1466	0.0046	0.0099	0.0104				
	4	0.1720	0.0055	0.0116	0.0122				
C(FIX)/C(IN)									
	32	0.1525	0.0050						
	64	0.1661	0.0051						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1388	0.0047
2	64	0.1543	0.0046
4	32	0.1662	0.0054
4	64	0.1779	0.0056

Table F8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, OPTIMAL CONTROL(DP)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2884

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.2745	0.3024	0.3295	0.2473	0.2949	0.2819	0.2369	0.3399
	8	0.2268	0.2471	0.2696	0.2043	0.2422	0.2317		
	16	0.3221	0.3576	0.3894	0.2904	0.3476	0.3322		
LEADTIME									
	2	0.2821	0.3076	0.3386	0.2511				
	4	0.2668	0.2971	0.3204	0.2435				
C(FIX)/C(IN)									
	32	0.3133	0.3456						
	64	0.2356	0.2591						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3238	0.3533
2	64	0.2404	0.2619
4	32	0.3028	0.3379
4	64	0.2308	0.2562

Appendix G

Multi-item Data for the Power Approximation

Stationary Model

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled Approximately Optimally with Full Information.

		page
Table G1	Sources of Expected Total Cost	G1
G3	Sources of Aggregate Period-End Inventory	G2
G4	Sources of Aggregate Backlog Cost	G3
G5	Sources of Aggregate Replenishment Cost	G4
G6	Backlog Frequency	G5
G7	Weighted Proportion of Demand Backlogged	G6
G8	Replenishment Frequency	G7
G15	Sources of Total Cost (% Excess Over DP)	G8
G16	Sources of Aggregate Period-End Inventory(% Excess Over DP)	G9
G17	Sources of Aggregate Backlog Cost (% Excess Over DP)	G10
G18	Sources of Aggregate Replenishment Cost (% Excess Over DP)	G11
G19	Backlog Frequency (% Excess Over DP)	G12
G20	Weighted Proportion of Demand Backlogged (% Excess Over DP)	G13
G21	Replenishment Frequency (% Excess Over DP)	G14

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices E and F.

Table G1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 760.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.6	61.4	45.2	54.8	47.4	52.6	41.8	58.2
MEAN									
8		16.1	25.8	19.0	22.9	19.8	22.0		
16		22.6	35.6	26.3	31.9	27.6	30.6		
LEADTIME									
2		18.5	28.9	21.2	26.1				
4		20.1	32.5	24.0	28.7				
C(FIX)/C(IN)									
32		17.0	28.2						
64		21.6	33.2						
LEADTIME	C(FIX)/C(IN)								
2	32	8.1	13.2						
2	64	10.4	15.7						
4	32	9.0	15.0						
4	64	11.2	17.5						

Table G3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 440.0 PERCENT OF TOTAL COST= 57.8

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	28.2	71.8	47.7	52.3	46.2	53.8	41.5	58.5
MEAN								
8	11.5	30.0	19.8	21.8	19.1	22.4		
16	16.7	41.8	27.9	30.5	27.1	31.4		
LEADTIME								
2	13.3	32.9	21.9	24.2				
4	14.9	38.9	25.8	28.1				
C(FIX)/C(IN)								
32	13.2	34.5						
64	15.1	37.2						

LEADTIME	C(FIX)/C(IN)		
2	32	6.2	15.7
2	64	7.1	17.1
4	32	7.0	18.8
4	64	8.0	20.1

Table G4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 109.1 PERCENT OF TOTAL COST= 14.3

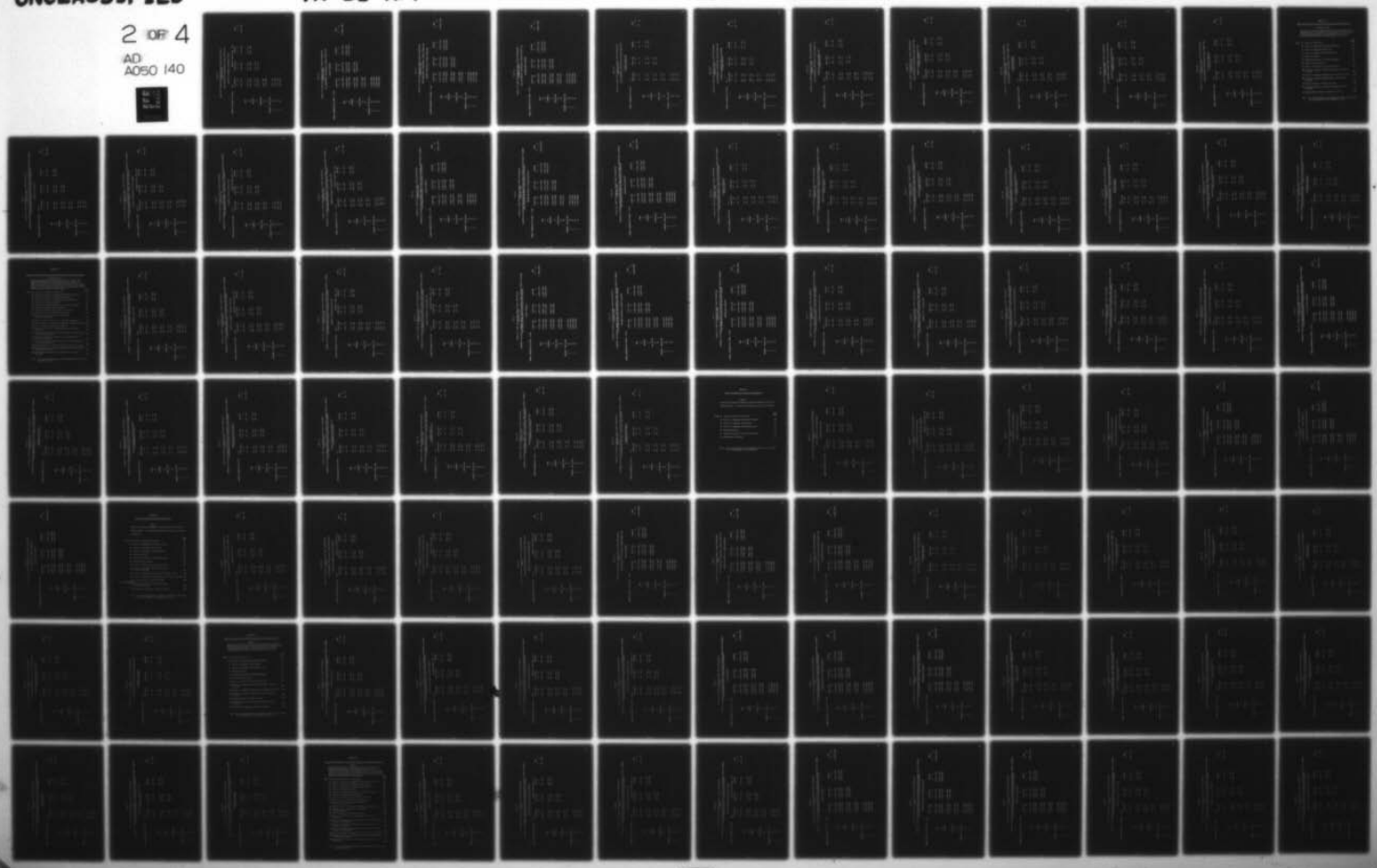
	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	58.5	41.5	45.4	54.6	45.6	54.4	43.7	56.3
MEAN								
8	25.2	18.5	20.1	23.6	20.3	23.4		
16	33.2	23.1	25.3	31.0	25.3	31.0		
LEADTIME								
2	26.2	19.4	20.6	24.9				
4	32.3	22.1	24.8	29.6				
C(FIX)/C(IN)								
32	26.9	18.5						
64	31.6	23.0						

LEADTIME	C(FIX)/C(IN)		
2	32	11.8	8.8
2	64	14.3	10.6
4	32	15.1	9.7
4	64	17.3	12.4

AD-A050 140 NORTH CAROLINA UNIV AT CHAPEL HILL GRADUATE SCHOOL OF--ETC F/G 15/5
(S,S) INVENTORY POLICIES IN A NONSTATIONARY DEMAND ENVIRONMENT.--ETC(U)
APR 77 R L KAUFMAN. DAAG29-76-G-0323

UNCLASSIFIED TR-11-APP ARO-14635.1-M-APP NL

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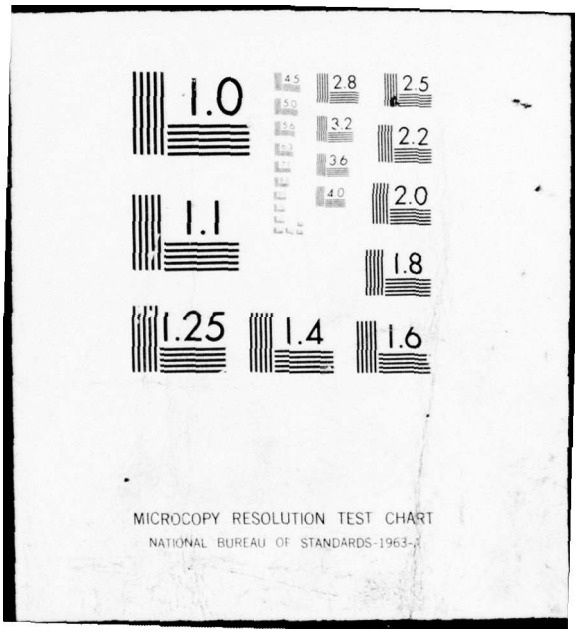

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Table G5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 211.7 PERCENT OF TOTAL COST= 27.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.0	50.0	40.0	60.0	50.8	49.2	41.5	58.5
MEAN									
8		20.7	20.7	16.7	24.8	21.1	20.4		
16		29.3	29.3	23.3	35.2	29.7	28.8		
LEADTIME									
2		25.4	25.4	20.1	30.6				
4		24.6	24.6	19.9	29.4				
C(FIX)/C(IN)									
32		20.0	20.0						
64		30.0	30.0						
LEADTIME	C(FIX)/C(IN)								
2	32	10.1	10.1						
2	64	15.3	15.3						
4	32	9.9	9.9						
4	64	14.7	14.7						

Table G6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1047

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2004	0.0090	0.1009	0.1085	0.1029	0.1065	0.1060	0.1034
MEAN									
	8	0.2029	0.0091	0.1028	0.1091	0.1038	0.1081		
	16	0.1980	0.0089	0.0990	0.1078	0.1019	0.1049		
LEADTIME									
	2	0.1966	0.0091	0.0982	0.1075				
	4	0.2043	0.0088	0.1036	0.1095				
C(FIX)/C(IN)									
	32	0.1937	0.0082						
	64	0.2072	0.0097						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1880	0.0084
2	64	0.2052	0.0098
4	32	0.1992	0.0080
4	64	0.2093	0.0096

Table G7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0110

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
	MEAN	0.1661	0.0048	0.0100	0.0120	0.0101	0.0120	0.0145	0.0093
	8	0.2151	0.0064	0.0133	0.0156	0.0134	0.0155		
	16	0.1415	0.0040	0.0084	0.0103	0.0084	0.0103		
	LEADTIME								
	2	0.1486	0.0045	0.0091	0.0110				
	4	0.1836	0.0051	0.0109	0.0131				
	C(FIX)/C(IN)								
	32	0.1528	0.0043						
	64	0.1794	0.0053						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1345	0.0040						
2	64	0.1627	0.0049						
4	32	0.1711	0.0045						
4	64	0.1961	0.0057						

Table G8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2894

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2894	0.2894	0.3308	0.2481	0.2932	0.2856	0.2406	0.3383
MEAN									
	8	0.2406	0.2406	0.2759	0.2052	0.2432	0.2379		
	16	0.3383	0.3383	0.3856	0.2910	0.3433	0.3333		
LEADTIME									
	2	0.2932	0.2932	0.3331	0.2534				
	4	0.2856	0.2856	0.3284	0.2429				
C(FIX)/C(IN)									
	32	0.3308	0.3308						
	64	0.2481	0.2481						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3331	0.3331
2	64	0.2534	0.2534
4	32	0.3284	0.3284
4	64	0.2429	0.2429

Table G15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	0.2	0.1	0.2	0.1	0.1	0.2	0.1	0.1

MEAN

8	0.2	0.1	0.1	0.1	0.1	0.2
16	0.1	0.2	0.2	0.1	0.1	0.2

LEADTIME

2	0.1	0.1	0.1	0.1
4	0.2	0.1	0.2	0.1

C(FIX)/C(IN)

32	0.2	0.2		
64	0.2	0.1		

LEADTIME	C(FIX)/C(IN)					
2	32	0.1	0.2			
2	64	0.2	0.1			
4	32	0.2	0.2			
4	64	0.2	0.1			

Table G16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-5.7	2.6	1.9	-1.4	0.6	-0.2	-1.3	1.2
MEAN								
8	-8.1	1.6	-0.4	-2.2	-1.6	-1.1		
16	-4.0	3.4	3.6	-0.9	2.1	0.4		
LEADTIME								
2	-4.0	2.5	3.1	-1.7				
4	-7.1	2.7	0.9	-1.2				
C(FIX)/C(IN)								
32	-3.5	4.2						
64	-7.6	1.3						

LEADTIME	C(FIX)/C(IN)		
2	32	-0.5	4.6
2	64	-7.0	0.7
4	32	-6.0	3.8
4	64	-8.1	1.8

Table G17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		4.2	-5.7	-6.9	6.3	-1.0	0.6	4.1	-3.2
MEAN									
	8	9.4	-2.3	-1.0	9.0	6.0	2.6		
	16	0.6	-8.3	-11.1	4.3	-6.0	-0.9		
LEADTIME									
	2	1.4	-4.1	-3.1	5.7				
	4	6.7	-7.2	-5.9	6.8				
C(FIX)/C(IN)									
	32	0.2	-15.5						
	64	8.0	4.0						

LEADTIME	C(FIX)/C(IN)		
2	32	-3.2	-13.9
2	64	5.4	6.0
4	32	3.0	-17.0
4	64	10.2	2.3

Table G18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.3

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	5.4	-4.3	0.4	0.3	-0.1	0.8	1.2	-0.3
MEAN								
8	5.8	-3.0	2.3	0.5	0.6	1.8		
16	5.2	-5.1	-1.0	0.2	-0.7	0.2		
LEADTIME								
2	4.4	-4.3	-1.6	0.9				
4	6.5	-4.3	2.5	-0.3				
C(FIX)/C(IN)								
32	5.6	-4.3						
64	5.3	-4.2						

LEADTIME	C(FIX)/C(IN)		
2	32	2.9	-5.7
2	64	5.4	-3.3
4	32	8.5	-2.8
4	64	5.2	-5.2

Table G19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 4.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	4.6	-5.3	0.9	7.4	1.9	6.5	7.7	0.8
MEAN								
8	8.2	-1.9	5.8	9.5	4.5	11.0		
16	1.2	-8.5	-3.7	5.3	-0.7	2.2		
LEADTIME								
2	2.1	-3.2	-1.8	5.5				
4	7.2	-7.4	3.7	9.3				
C(FIX)/C(IN)								
32	1.7	-13.9						
64	7.6	3.5						

LEADTIME	C(FIX)/C(IN)		
2	32	-1.3	-12.4
2	64	5.4	6.5
4	32	4.6	-15.4
4	64	9.8	0.5

Table G20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	4.2	-5.7	-6.9	6.3	-1.0	0.6	4.1	-3.2
MEAN								
8	9.4	-2.3	-1.0	9.0	6.0	2.6		
16	0.6	-8.3	-11.1	4.3	-6.0	-0.9		
LEADTIME								
2	1.4	-4.1	-8.1	5.7				
4	6.7	-7.2	-5.9	6.8				
C(FIX)/C(IN)								
32	0.2	-15.5						
64	8.0	4.0						

LEADTIME	C(FIX)/C(IN)		
2	32	-3.2	-13.9
2	64	5.4	6.0
4	32	3.0	-17.0
4	64	10.2	2.3

Table G21

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.4

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	5.5	-4.3	0.4	0.3	-0.6	1.3	1.5	-0.5
MEAN								
8	6.1	-2.6	2.3	0.5	0.4	2.7		
16	5.0	-5.4	-1.0	0.2	-1.2	0.4		
LEADTIME								
2	4.0	-4.7	-1.6	0.9				
4	7.1	-3.8	2.5	-0.3				
C(FIX)/C(IN)								
32	5.6	-4.3						
64	5.3	-4.2						

LEADTIME	C(FIX)/C(IN)		
2	32	2.9	-5.7
2	64	5.4	-3.3
4	32	8.5	-2.8
4	64	5.2	-5.2

Appendix H

Multi-item Data for the (24,24) Statistical Power Approximation

Stationary Model

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information from a 24-Period Demand History, with Revision Every 24 Periods, Using Regression Estimates of Demand Means and Variances.

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Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices K and L.

Table H1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 813.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		37.4	62.6	45.6	54.4	46.8	53.2	42.0	58.0
MEAN									
8		15.6	26.4	19.2	22.7	19.6	22.4		
16		21.8	36.2	26.4	31.6	27.1	30.9		
LEADTIME									
2		17.7	29.0	21.2	25.6				
4		19.6	33.6	24.5	28.8				
C(FIX)/C(IN)									
32		16.6	29.1						
64		20.8	33.6						
LEADTIME	C(FIX)/C(IN)								
2	32	7.8	13.4						
2	64	9.9	15.6						
4	32	8.8	15.7						
4	64	10.8	17.9						

Table H3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 462.9 PERCENT OF TOTAL COST= 56.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.8	71.2	47.8	52.2	45.7	54.3	41.7	58.3
MEAN									
	8	11.7	30.0	19.9	21.8	19.0	22.7		
	16	17.1	41.2	27.9	30.4	26.7	31.6		
LEADTIME									
	2	13.3	32.5	21.7	24.1				
	4	15.6	38.7	26.1	28.1				
C(FIX)/C(IN)									
	32	13.5	34.3						
	64	15.3	36.9						

LEADTIME	C(FIX)/C(IN)		
2	32	6.1	15.5
2	64	7.1	16.9
4	32	7.3	18.8
4	64	8.2	19.9

Table H4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 137.6 PERCENT OF TOTAL COST= 16.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		46.4	53.6	47.2	52.8	44.0	56.0	43.4	56.6
MEAN									
8		20.3	23.1	20.7	22.7	19.3	24.1		
16		26.1	30.5	26.5	30.1	24.7	31.9		
LEADTIME									
2		20.9	23.1	20.7	23.3				
4		25.5	30.5	26.5	29.5				
C(FIX)/C(IN)									
32		21.6	25.6						
64		24.7	28.1						
LEADTIME	C(FIX)/C(IN)								
2	32	9.6	11.1						
2	64	11.2	12.1						
4	32	12.0	14.5						
4	64	13.5	16.0						

Table H5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 212.9 PERCENT OF TOTAL COST= 26.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.1	49.9	40.0	60.0	50.8	49.2	41.6	58.4
MEAN									
8		20.8	20.7	16.7	24.8	21.1	20.5		
16		29.3	29.1	23.2	35.2	29.7	28.7		
LEADTIME									
2		25.5	25.3	20.3	30.5				
4		24.7	24.5	19.6	29.6				
C(FIX)/C(IN)									
32		20.0	19.9						
64		30.1	29.9						
LEADTIME	C(FIX)/C(IN)								
2	32	10.2	10.1						
2	64	15.3	15.2						
4	32	9.8	9.8						
4	64	14.8	14.7						

Table H6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1043

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1955	0.0131	0.1015	0.1070	0.1034	0.1051	0.1063	0.1022
MEAN									
	8	0.1997	0.0130	0.1036	0.1091	0.1060	0.1067		
	16	0.1913	0.0131	0.0994	0.1050	0.1009	0.1035		
LEADTIME									
	2	0.1944	0.0125	0.1002	0.1066				
	4	0.1966	0.0136	0.1028	0.1074				
C(FIX)/C(IN)									
	32	0.1904	0.0126						
	64	0.2006	0.0135						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1884	0.0121
2	64	0.2004	0.0129
4	32	0.1924	0.0131
4	64	0.2007	0.0141

Table H7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0139

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1661	0.0078	0.0131	0.0147	0.0122	0.0156	0.0181	0.0118
MEAN									
	8	0.2176	0.0100	0.0173	0.0189	0.0161	0.0201		
	16	0.1403	0.0066	0.0110	0.0126	0.0103	0.0133		
LEADTIME									
	2	0.1494	0.0067	0.0115	0.0129				
	4	0.1828	0.0088	0.0147	0.0164				
C(FIX)/C(IN)									
	32	0.1589	0.0074						
	64	0.1773	0.0081						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1382	0.0064
2	64	0.1606	0.0070
4	32	0.1716	0.0084
4	64	0.1939	0.0093

Table H8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2910

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2918	0.2903	0.3323	0.2497	0.2956	0.2864	0.2425	0.3396
MEAN									
	8	0.2431	0.2419	0.2784	0.2065	0.2458	0.2392		
	16	0.3405	0.3387	0.3862	0.2929	0.3455	0.3337		
LEADTIME									
	2	0.2965	0.2948	0.3379	0.2534				
	4	0.2871	0.2858	0.3268	0.2460				
C(FIX)/C(IN)									
	32	0.3330	0.3317						
	64	0.2505	0.2489						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3389	0.3369
2	64	0.2541	0.2527
4	32	0.3272	0.3265
4	64	0.2470	0.2451

Table H15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 7.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	3.6	9.2	8.1	6.2	5.7	8.3	7.4	6.8
MEAN								
8	3.9	9.6	8.6	6.4	6.0	8.7		
16	3.4	9.0	7.7	6.1	5.4	8.1		
LEADTIME								
2	2.6	7.6	6.6	4.9				
4	4.5	10.7	9.4	7.4				
C(FIX)/C(IN)								
32	4.1	10.5						
64	3.2	8.2						

LEADTIME	C(FIX)/C(IN)		
2	32	3.1	8.8
2	64	2.3	6.6
4	32	5.0	12.0
4	64	4.1	9.6

Table H16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 5.4

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	1.3	7.1	7.5	3.5	4.8	5.8	4.3	6.1
MEAN								
8	-1.5	6.8	5.7	3.1	3.3	5.2		
16	3.3	7.4	8.8	3.8	5.9	6.3		
LEADTIME								
2	0.8	6.5	7.2	2.7				
4	1.7	7.6	7.7	4.2				
C(FIX)/C(IN)								
32	3.9	9.0						
64	-0.9	5.4						

LEADTIME	C(FIX)/C(IN)		
2	32	3.7	8.7
2	64	-1.6	4.6
4	32	4.1	9.2
4	64	-0.3	6.1

Table H17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 25.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		4.3	53.5	21.9	29.7	20.5	30.6	30.4	22.7
MEAN									
8		10.7	54.5	28.5	32.2	27.2	33.1		
16		-0.2	52.8	17.2	27.9	15.7	28.7		
LEADTIME									
2		1.9	44.1	16.3	24.4				
4		6.2	61.5	26.7	34.2				
C(FIX)/C(IN)									
32		1.6	46.8						
64		6.7	60.1						
LEADTIME	C(FIX)/C(IN)								
2	32	-0.5	36.4						
2	64	4.1	52.0						
4	32	3.3	55.9						
4	64	9.0	66.9						

Table H18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.9

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.3	-4.0	0.9	1.0	0.4	1.4	2.0	0.2
MEAN								
8	6.9	-2.5	3.3	1.1	1.2	2.8		
16	5.9	-5.0	-0.8	0.9	-0.1	0.5		
LEADTIME								
2	5.3	-4.0	-0.2	0.9				
4	7.4	-4.0	2.0	1.0				
C(FIX)/C(IN)								
32	6.3	-4.0						
64	6.3	-3.9						

LEADTIME	C(FIX)/C(IN)		
2	32	4.6	-4.7
2	64	5.7	-3.5
4	32	8.1	-3.4
4	64	7.0	-4.3

Table H19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 3.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	2.0	38.1	1.5	5.9	2.4	5.1	8.1	-0.4
MEAN								
8	6.5	41.0	6.7	9.5	6.6	9.6		
16	-2.2	35.3	-3.4	2.5	-1.6	0.8		
LEADTIME								
2	0.9	32.6	0.2	4.6				
4	3.1	43.6	2.8	7.3				
C(FIX)/C(IN)								
32	-0.1	32.6						
64	4.1	43.7						

LEADTIME	C(FIX)/C(IN)		
2	32	-1.1	25.6
2	64	3.0	39.9
4	32	1.0	39.8
4	64	5.3	47.3

Table H20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 25.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		4.3	53.5	21.9	29.7	20.5	30.6	30.4	22.7
MEAN									
8		10.7	54.5	28.5	32.2	27.2	33.1		
16		-0.2	52.8	17.2	27.9	15.7	28.7		
LEADTIME									
2		1.9	48.1	16.3	24.4				
4		6.2	61.5	26.7	34.2				
C(FIX)/C(IN)									
32		1.6	46.8						
64		6.7	60.1						
LEADTIME	C(FIX)/C(IN)								
2	32	-0.5	36.4						
2	64	4.1	52.0						
4	32	3.3	55.9						
4	64	9.0	66.9						

Table H21

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.9

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.3	-4.0	0.9	1.0	0.3	1.6	2.3	-0.1
MEAN								
8	7.2	-2.1	3.3	1.1	1.5	3.2		
16	5.7	-5.3	-0.8	0.9	-0.6	0.5		
LEADTIME								
2	5.1	-4.2	-0.2	0.9				
4	7.6	-3.8	2.0	1.0				
C(FIX)/C(IN)								
32	6.3	-4.0						
64	6.3	-3.9						

LEADTIME	C(FIX)/C(IN)		
2	32	4.6	-4.7
2	64	5.7	-3.5
4	32	8.1	-3.4
4	64	7.0	-4.3

Appendix I

Multi-item Forecasts for the (24,24) Statistical Power Approximation

Stationary Model

Forecasting Properties of Inventory System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information, Revision Taking Place Every 24 Periods Using a 24-Period Demand History and Regression Estimates of Demand Means and Variances. Forecasts Made at Each Revision Using a 24-Period Demand History.

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Note: The corresponding appendices in MacCormick (1974), are his Appendices T and U.

Table II

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 739.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		39.0	61.0	45.1	54.9	47.9	52.1	41.8	58.2
MEAN									
	8	16.3	25.5	18.9	22.9	20.0	21.8		
	16	22.7	35.5	26.2	32.0	27.9	30.3		
LEADTIME									
	2	18.8	29.1	21.4	26.6				
	4	20.2	31.9	23.7	28.4				
C(FIX)/C(IN)									
	32	17.1	27.9						
	64	21.9	33.0						

LEADTIME	C(FIX)/C(IN)		
2	32	8.2	13.2
2	64	10.6	15.9
4	32	8.9	14.8
4	64	11.2	17.1

Table I2

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 449.5 PERCENT OF TOTAL COST= 60.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.0	72.0	47.7	52.3	46.1	53.9	41.7	58.3
MEAN									
	8	11.4	30.3	19.9	21.8	19.2	22.5		
	16	16.6	41.7	27.8	30.5	26.9	31.4		
LEADTIME									
	2	13.1	33.0	21.8	24.3				
	4	14.9	39.0	25.9	28.0				
C(FIX)/C(IN)									
	32	13.0	34.7						
	64	15.0	37.3						
LEADTIME	C(FIX)/C(IN)								
2	32	6.0	15.8						
2	64	7.1	17.2						
4	32	7.0	18.9						
4	64	7.9	20.1						

Table I3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 78.2 PERCENT OF TOTAL COST= 10.6

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		72.5	27.5	43.7	56.3	50.7	49.3	43.6	56.4
MEAN									
8		32.2	11.3	18.7	24.9	22.2	21.4		
16		40.2	16.2	25.0	31.4	28.5	27.9		
LEADTIME									
2		34.1	16.6	21.8	28.8				
4		38.4	10.9	21.8	27.5				
C(FIX)/C(IN)									
32		33.0	10.7						
64		39.5	16.9						
LEADTIME	C(FIX)/C(IN)								
2	32	15.5	6.4						
2	64	18.6	10.2						
4	32	17.6	4.3						
4	64	20.9	6.7						

Table I4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 212.1 PERCENT OF TOTAL COST= 28.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.1	49.9	40.0	60.0	50.8	49.2	41.4	58.6
MEAN									
8		20.8	20.6	16.7	24.7	21.0	20.4		
16		29.3	29.3	23.3	35.3	29.8	28.8		
LEADTIME									
2		25.4	25.4	20.3	30.5				
4		24.7	24.6	19.7	29.5				
C(FIX)/C(IN)									
32		20.0	20.0						
64		30.0	30.0						
LEADTIME	C(FIX)/C(IN)								
2	32	10.2	10.2						
2	64	15.2	15.2						
4	32	9.9	9.8						
4	64	14.8	14.7						

Table I5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.0983

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1912	0.0055	0.0949	0.1018	0.0989	0.0978	0.1002	0.0965
MEAN									
	8	0.1953	0.0052	0.0965	0.1039	0.0995	0.1009		
	16	0.1871	0.0058	0.0933	0.0996	0.0982	0.0947		
LEADTIME									
	2	0.1910	0.0067	0.0961	0.1016				
	4	0.1914	0.0043	0.0936	0.1020				
C(FIX)/C(IN)									
	32	0.1852	0.0046						
	64	0.1972	0.0064						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1861	0.0061
2	64	0.1959	0.0072
4	32	0.1843	0.0030
4	64	0.1984	0.0055

Table I6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0079

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
	MEAN	0.1476	0.0023	0.0069	0.0089	0.0080	0.0078	0.0103	0.0067
	8	0.1969	0.0028	0.0089	0.0118	0.0105	0.0102		
	16	0.1229	0.0020	0.0059	0.0075	0.0068	0.0066		
	LEADTIME								
	2	0.1387	0.0027	0.0069	0.0091				
	4	0.1564	0.0018	0.0069	0.0087				
	C(FIX)/C(IN)								
	32	0.1345	0.0018						
	64	0.1607	0.0028						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1260	0.0021						
2	64	0.1515	0.0034						
4	32	0.1430	0.0014						
4	64	0.1699	0.0022						

Table I7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2899

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2904	0.2895	0.3314	0.2485	0.2945	0.2854	0.2405	0.3394
MEAN									
	8	0.2412	0.2398	0.2763	0.2047	0.2442	0.2368		
	16	0.3396	0.3392	0.3864	0.2924	0.3448	0.3340		
LEADTIME									
	2	0.2947	0.2943	0.3367	0.2523				
	4	0.2861	0.2847	0.3260	0.2448				
C(FIX)/C(IN)									
	32	0.3320	0.3307						
	64	0.2488	0.2483						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3371	0.3363
2	64	0.2523	0.2523
4	32	0.3269	0.3251
4	64	0.2453	0.2443

Table I8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF VARIANCE OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 1277.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		14.4	85.6	43.3	56.7	47.5	52.5	37.7	62.3
MEAN									
8		6.2	31.5	15.2	22.5	18.8	18.9		
16		8.2	54.1	28.1	34.2	28.7	33.6		
LEADTIME									
2		4.5	43.0	17.0	30.5				
4		9.8	42.7	26.3	26.2				
C(FIX)/C(IN)									
32		7.0	36.3						
64		7.4	49.3						
LEADTIME	C(FIX)/C(IN)								
2	32	2.2	14.8						
2	64	2.4	28.1						
4	32	4.8	21.5						
4	64	5.0	21.2						

Table I9

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 35.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		13.5	33.1	23.5	26.9	24.6	25.9	22.0	28.2
MEAN									
8		8.9	20.1	13.9	16.9	15.5	15.5		
16		10.2	26.3	18.9	20.9	19.1	20.7		
LEADTIME									
2		7.6	23.4	14.7	19.7				
4		11.2	23.4	18.3	18.3				
C(FIX)/C(IN)									
32		9.4	21.5						
64		9.7	25.1						
LEADTIME	C(FIX)/C(IN)								
2	32	5.3	13.8						
2	64	5.5	19.0						
4	32	7.9	16.6						
4	64	8.0	16.5						

Table I10

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 20.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		6.8	18.9	14.5	13.9	11.9	16.2	12.5	15.7
MEAN									
8		4.2	11.8	9.0	8.7	7.5	10.1		
16		5.4	14.7	11.4	10.8	9.3	12.6		
LEADTIME									
2		3.6	11.3	8.6	8.2				
4		5.8	15.1	11.7	11.2				
C(FIX)/C(IN)									
32		4.8	13.6						
64		4.8	13.0						
LEADTIME	C(FIX)/C(IN)								
2	32	2.6	8.2						
2	64	2.5	7.9						
4	32	4.1	10.9						
4	64	4.1	10.4						

Table I11

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 28.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		10.0	26.1	17.3	22.0	20.7	18.8	16.7	22.5
MEAN									
8		6.4	15.4	9.6	13.6	12.8	10.6		
16		7.7	21.1	14.5	17.2	16.3	15.5		
LEADTIME									
2		5.6	20.0	11.7	17.1				
4		8.3	16.9	12.8	13.8				
C(FIX)/C(IN)									
32		6.8	15.9						
64		7.3	20.7						
LEADTIME	C(FIX)/C(IN)								
2	32	3.7	11.1						
2	64	4.2	16.6						
4	32	5.7	11.4						
4	64	6.0	12.4						

Table I12

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 5.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	3.5	3.6	2.7	4.2	3.3	3.8	3.5	3.6
MEAN								
8	2.4	2.6	1.8	3.0	2.3	2.6		
16	2.5	2.5	2.0	2.9	2.3	2.7		
LEADTIME								
2	2.3	2.4	1.8	2.7				
4	2.6	2.7	2.0	3.2				
C(FIX)/C(IN)								
32	1.9	2.0						
64	2.9	3.0						

LEADTIME	C(FIX)/C(IN)		
2	32	1.3	1.3
2	64	1.9	1.9
4	32	1.4	1.4
4	64	2.2	2.3

Table I13

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

S.D. OF BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1674

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1625	0.0402	0.1193	0.1174	0.1141	0.1224	0.1245	0.1118
MEAN									
	8	0.1213	0.0283	0.0870	0.0891	0.0858	0.0903		
	16	0.1081	0.0286	0.0817	0.0763	0.0753	0.0827		
LEADTIME									
	2	0.1099	0.0308	0.0802	0.0812				
	4	0.1197	0.0258	0.0883	0.0848				
C(FIX)/C(IN)									
	32	0.1164	0.0262						
	64	0.1133	0.0305						

LEADTIME	C(FIX)/C(IN)		
2	32	0.0775	0.0209
2	64	0.0779	0.0226
4	32	0.0869	0.0158
4	64	0.0823	0.0204

Table I14

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 9.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	5.0	11.5	10.2	8.1	6.8	11.1	9.4	8.8
MEAN								
8	4.8	12.1	10.8	8.3	7.1	11.4		
16	5.1	11.0	9.8	7.9	6.5	10.8		
LEADTIME								
2	3.4	8.8	8.1	5.6				
4	6.5	13.7	12.0	10.2				
C(FIX)/C(IN)								
32	5.9	12.7						
64	4.3	10.4						

LEADTIME	C(FIX)/C(IN)		
2	32	4.2	10.4
2	64	2.7	7.5
4	32	7.5	14.6
4	64	5.7	13.0

Table I15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 2.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		5.7	1.8	3.1	2.7	2.1	3.6	3.0	2.8
MEAN									
8		5.7	1.9	2.9	3.1	2.1	3.7		
16		5.6	1.6	3.3	2.4	2.0	3.5		
LEADTIME									
2		4.1	1.3	2.4	1.8				
4		7.0	2.2	3.7	3.4				
C(FIX)/C(IN)									
32		6.3	1.9						
64		5.1	1.7						
LEADTIME	C(FIX)/C(IN)								
2	32	4.9	1.4						
2	64	3.3	1.1						
4	32	7.5	2.3						
4	64	6.6	2.1						

Table I16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 43.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		11.1	70.8	47.4	39.4	34.5	49.9	42.9	43.3
MEAN									
8		9.5	72.1	48.7	37.6	34.7	49.5		
16		12.4	69.8	46.3	40.7	34.4	50.2		
LEADTIME									
2		7.1	59.2	40.1	29.6				
4		14.4	79.6	53.1	47.0				
C(FIX)/C(IN)									
32		13.2	76.3						
64		9.3	65.8						
LEADTIME	C(FIX)/C(IN)								
2	32	8.9	67.2						
2	64	5.6	51.9						
4	32	16.7	83.2						
4	64	12.4	76.3						

Table I17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 0.4

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	0.5	0.3	0.3	0.5	0.4	0.4	0.8	0.1
MEAN								
8	0.8	0.9	0.8	0.9	0.7	1.0		
16	0.3	-0.2	-0.0	0.2	0.2	-0.0		
LEADTIME								
2	0.6	0.2	0.3	0.4				
4	0.4	0.4	0.3	0.5				
C(FIX)/C(IN)								
32	0.3	0.3						
64	0.7	0.3						

LEADTIME	C(FIX)/C(IN)		
2	32	0.5	0.2
2	64	0.7	0.2
4	32	0.1	0.4
4	64	0.7	0.3

Table I18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 5.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	2.2	58.2	6.5	4.9	4.4	6.9	5.8	5.6
MEAN								
8	2.2	60.4	6.9	4.7	6.1	5.5		
16	2.2	55.9	6.1	5.1	2.7	8.4		
LEADTIME								
2	1.7	46.6	4.1	4.8				
4	2.6	68.7	8.9	5.1				
C(FIX)/C(IN)								
32	2.7	63.7						
64	1.7	53.0						

LEADTIME	C(FIX)/C(IN)		
2	32	1.2	49.3
2	64	2.2	44.2
4	32	4.2	77.0
4	64	1.2	61.0

Table I19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 43.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		11.1	70.8	47.4	39.4	34.5	49.9	42.9	43.3
MEAN									
8		9.5	72.1	48.7	37.6	34.7	49.5		
16		12.4	69.8	46.3	40.7	34.4	50.2		
LEADTIME									
2		7.1	59.2	40.1	29.6				
4		14.4	79.6	53.1	47.0				
C(FIX)/C(IN)									
32		13.2	76.3						
64		9.3	65.8						
LEADTIME	C(FIX)/C(IN)								
2	32	8.9	67.2						
2	64	5.6	51.9						
4	32	16.7	83.2						
4	64	12.4	76.3						

Table I20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
STATIONARY MODEL

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 0.4

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	0.5	0.3	0.3	0.5	0.4	0.4	0.8	0.1
MEAN								
8	0.8	0.9	0.8	0.9	0.7	1.0		
16	0.3	-0.2	-0.0	0.2	0.2	-0.1		
LEADTIME								
2	0.6	0.2	0.3	0.4				
4	0.3	0.4	0.3	0.5				
C(FIX)/C(IN)								
32	0.3	0.3						
64	0.7	0.3						

LEADTIME	C(FIX)/C(IN)		
2	32	0.5	0.2
2	64	0.7	0.2
4	32	0.1	0.4
4	64	0.7	0.3

Appendix J

Multi-item Data for the Power Approximation

Model I

System of 16 Items with Negative Binomial Demand Distributions

(Variance/Mean = 3) Controlled Optimally with Full Information.

		page
Table J1	Sources of Expected Total Cost	J1
J3	Sources of Aggregate Period-End Inventory	J2
J4	Sources of Aggregate Backlog Cost	J3
J5	Sources of Aggregate Replenishment Cost	J4
J6	Backlog Frequency	J5
J7	Weighted Proportion of Demand Backlogged	J6
J8	Replenishment Frequency	J7

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendix C.

Table J1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 746.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.7	61.3	45.3	54.7	47.3	52.7	41.9	58.1
MEAN									
8		16.1	25.8	19.0	22.8	19.8	22.1		
16		22.6	35.5	26.2	31.9	27.5	30.6		
LEADTIME									
2		18.5	28.8	21.2	26.1				
4		20.2	32.6	24.0	28.7				
C(FIX)/C(IN)									
32		17.1	28.2						
64		21.6	33.1						
LEADTIME	C(FIX)/C(IN)								
2	32	8.1	13.1						
2	64	10.4	15.6						
4	32	9.0	15.1						
4	64	11.2	17.5						

Table J3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 432.9 PERCENT OF TOTAL COST= 58.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		30.1	69.9	47.0	53.0	45.9	54.1	42.4	57.6
MEAN									
	8	12.6	29.8	19.8	22.6	19.5	22.9		
	16	17.5	40.1	27.2	30.4	26.4	31.2		
LEADTIME									
	2	14.0	31.9	21.4	24.5				
	4	16.1	38.0	25.6	28.5				
C(FIX)/C(IN)									
	32	13.8	33.3						
	64	16.3	36.6						

LEADTIME	C(FIX)/C(IN)		
2	32	6.3	15.1
2	64	7.7	16.8
4	32	7.4	18.2
4	64	8.7	19.8

Table J4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, OPTIMAL CONTROL (DP)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 105.7 PERCENT OF TOTAL COST= 14.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		56.8	43.2	48.7	51.3	45.5	54.5	42.9	57.1
MEAN									
	8	24.1	18.8	21.0	21.9	19.6	23.3		
	16	32.7	24.4	27.7	29.4	25.9	31.2		
LEADTIME									
	2	25.8	19.7	22.2	23.3				
	4	31.0	23.5	26.5	28.0				
C(FIX)/C(IN)									
	32	27.3	21.4						
	64	29.5	21.8						

LEADTIME	C(FIX)/C(IN)		
2	32	12.4	9.8
2	64	13.4	9.9
4	32	14.8	11.7
4	64	16.1	11.8

Table J5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 208.0 PERCENT OF TOTAL COST= 27.9

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	47.3	52.7	39.8	60.2	51.1	48.9	40.4	59.6
MEAN								
8	19.2	21.2	16.5	23.9	20.6	19.7		
16	28.1	31.6	23.4	36.3	30.5	29.2		
LEADTIME								
2	24.2	26.9	20.3	30.8				
4	23.1	25.8	19.5	29.4				
C(FIX)/C(IN)								
32	18.8	21.1						
64	28.5	31.7						

LEADTIME	C(FIX)/C(IN)		
2	32	9.6	10.8
2	64	14.6	16.1
4	32	9.2	10.3
4	64	13.9	15.5

Table J6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, OPTIMAL CONTROL(DP)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1005

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1919	0.0092	0.1003	0.1008	0.1003	0.1008	0.1000	0.1011
MEAN									
	8	0.1908	0.0091	0.0998	0.1001	0.0997	0.1003		
	16	0.1929	0.0094	0.1008	0.1015	0.1009	0.1014		
LEADTIME									
	2	0.1914	0.0092	0.1003	0.1003				
	4	0.1924	0.0093	0.1003	0.1013				
C(FIX)/C(IN)									
	32	0.1914	0.0092						
	64	0.1924	0.0092						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1914	0.0092
2	64	0.1914	0.0092
4	32	0.1913	0.0093
4	64	0.1934	0.0093

Table J7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, OPTIMAL CONTROL(DP)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0107

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.1564	0.0048	0.0104	0.0110	0.0097	0.0116	0.0138	0.0092
	8	0.1988	0.0063	0.0135	0.0140	0.0126	0.0150		
	16	0.1352	0.0041	0.0089	0.0094	0.0083	0.0100		
LEADTIME									
	2	0.1422	0.0044	0.0095	0.0100				
	4	0.1706	0.0052	0.0113	0.0120				
C(FIX)/C(IN)									
	32	0.1502	0.0048						
	64	0.1626	0.0048						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1368	0.0043
2	64	0.1476	0.0044
4	32	0.1635	0.0052
4	64	0.1777	0.0053

Table J8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, OPTIMAL CONTROL (DP)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2841

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.2683	0.2999	0.3237	0.2444	0.2901	0.2781	0.2309	0.3373
	8	0.2186	0.2431	0.2676	0.1941	0.2356	0.2262		
	16	0.3179	0.3566	0.3799	0.2947	0.3446	0.3299		
LEADTIME									
	2	0.2740	0.3061	0.3302	0.2499				
	4	0.2625	0.2936	0.3172	0.2389				
C(FIX)/C(IN)									
	32	0.3051	0.3424						
	64	0.2315	0.2573						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3104	0.3501
2	64	0.2376	0.2621
4	32	0.2997	0.3347
4	64	0.2253	0.2525

Appendix K

Multi-item Data for the Power Approximation

Model I

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled Approximately Optimally with Full Information.

		page
Table K1	Sources of Expected Total Cost	K1
K3	Sources of Aggregate Period-End Inventory	K2
K4	Sources of Aggregate Backlog Cost	K3
K5	Sources of Aggregate Replenishment Cost	K4
K6	Backlog Frequency	K5
K7	Weighted Proportion of Demand Backlogged	K6
K8	Replenishment Frequency	K7
K15	Sources of Total Cost (% Excess Over DP)	K8
K16	Sources of Aggregate Period-End Inventory (% Excess Over DP)	K9
K17	Sources of Aggregate Backlog Cost (% Excess Over DP)	K10
K18	Sources of Aggregate Replenishment Cost (% Excess Over DP)	K11
K19	Backlog Frequency (% Excess Over DP)	K12
K20	Weighted Proportion of Demand Backlogged (% Excess Over DP)	K13
K21	Replenishment Frequency (% Excess Over DP)	K14

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices E and F.

Table K1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 757.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.6	61.4	45.2	54.8	47.4	52.6	41.9	58.1
MEAN									
	8	16.1	25.9	19.0	22.9	19.9	22.1		
	16	22.5	35.5	26.2	31.8	27.5	30.6		
LEADTIME									
	2	18.5	28.9	21.2	26.1				
	4	20.1	32.5	24.0	28.7				
C(FIX)/C(IN)									
	32	17.0	28.2						
	64	21.6	33.2						

LEADTIME	C(FIX)/C(IN)		
2	32	8.1	13.2
2	64	10.4	15.7
4	32	8.9	15.0
4	64	11.2	17.5

Table K3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 445.4 PERCENT OF TOTAL COST= 58.8

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	28.5	71.5	47.4	52.6	46.4	53.6	41.6	58.4
MEAN								
8	11.5	30.1	19.8	21.8	19.2	22.4		
16	17.0	41.4	27.7	30.7	27.2	31.2		
LEADTIME								
2	13.4	33.0	21.8	24.6				
4	15.1	38.5	25.7	28.0				
C(FIX)/C(IN)								
32	13.2	34.2						
64	15.3	37.3						

LEADTIME	C(FIX)/C(IN)		
2	32	6.1	15.6
2	64	7.3	17.3
4	32	7.1	18.6
4	64	8.0	19.9

Table K4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 104.7 PERCENT OF TOTAL COST= 13.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		58.3	41.7	46.7	53.3	45.4	54.6	43.8	56.2
MEAN									
	8	25.8	18.0	20.2	23.6	20.4	23.4		
	16	32.5	23.7	26.5	29.6	25.0	31.2		
LEADTIME									
	2	26.3	19.1	21.4	24.0				
	4	32.0	22.6	25.3	29.3				
C(FIX)/C(IN)									
	32	27.4	19.4						
	64	30.9	22.3						
LEADTIME	C(FIX)/C(IN)								
2	32	12.3	9.1						
2	64	14.0	9.9						
4	32	15.1	10.2						
4	64	16.9	12.4						

Table K5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 206.9 PERCENT OF TOTAL COST= 27.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.3	49.7	39.6	60.4	50.5	49.5	41.7	58.3
MEAN									
	8	21.0	20.7	16.7	25.0	21.0	20.6		
	16	29.4	29.0	22.9	35.4	29.5	28.9		
LEADTIME									
	2	25.5	25.0	20.0	30.5				
	4	24.9	24.6	19.6	29.9				
C(FIX)/C(IN)									
	32	20.0	19.7						
	64	30.4	30.0						
LEADTIME	C(FIX)/C(IN)								
2	32	10.1	9.9						
2	64	15.3	15.1						
4	32	9.9	9.7						
4	64	15.0	14.9						

Table K6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1018

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
	MEAN	0.1949	0.0087	0.0996	0.1040	0.1010	0.1025	0.1047	0.0988
	8	0.2009	0.0085	0.1027	0.1068	0.1055	0.1040		
	16	0.1889	0.0088	0.0965	0.1012	0.0965	0.1011		
	LEADTIME								
	2	0.1934	0.0086	0.0988	0.1033				
	4	0.1964	0.0087	0.1004	0.1047				
	C(FIX)/C(IN)								
	32	0.1910	0.0082						
	64	0.1988	0.0092						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1892	0.0083						
2	64	0.1976	0.0089						
4	32	0.1928	0.0080						
4	64	0.2000	0.0094						

Table K7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0106

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.1590	0.0046	0.0099	0.0113	0.0096	0.0116	0.0139	0.0089
	8	0.2112	0.0060	0.0128	0.0150	0.0130	0.0149		
	16	0.1329	0.0039	0.0084	0.0094	0.0079	0.0099		
LEADTIME									
	2	0.1436	0.0042	0.0091	0.0102				
	4	0.1744	0.0050	0.0107	0.0124				
C(FIX)/C(IN)									
	32	0.1492	0.0043						
	64	0.1687	0.0049						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1341	0.0040
2	64	0.1531	0.0044
4	32	0.1644	0.0045
4	64	0.1844	0.0055

Table K8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2821

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2842	0.2801	0.3203	0.2439	0.2850	0.2792	0.2359	0.3283
MEAN									
	8	0.2375	0.2342	0.2702	0.2016	0.2384	0.2334		
	16	0.3308	0.3259	0.3705	0.2862	0.3316	0.3251		
LEADTIME									
	2	0.2875	0.2825	0.3238	0.2462				
	4	0.2809	0.2776	0.3169	0.2416				
C(FIX)/C(IN)									
	32	0.3229	0.3177						
	64	0.2455	0.2424						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3269	0.3206
2	64	0.2480	0.2444
4	32	0.3189	0.3148
4	64	0.2429	0.2403

Table K15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 1.4

C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
4	99	32	64	2	4	8	16
1.2	1.5	1.2	1.5	1.6	1.2	1.5	1.3

MEAN					
8	1.4	1.6	1.2	1.8	1.7	1.4
16	1.0	1.4	1.3	1.3	1.5	1.1

LEADTIME					
2	1.2	1.8	1.4	1.7	
4	1.2	1.3	1.1	1.4	

C(FIX)/C(IN)		
32	1.0	1.4
64	1.4	1.6

LEADTIME	C(FIX)/C(IN)		
2	32	1.1	1.7
2	64	1.4	1.9
4	32	0.9	1.2
4	64	1.4	1.4

Table K16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 2.9

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-2.6	5.3	3.7	2.1	4.0	2.0	1.1	4.2
MEAN								
8	-6.1	4.1	2.8	-0.4	1.4	0.8		
16	-0.1	6.1	4.4	4.0	5.9	2.8		
LEADTIME								
2	-1.5	6.4	4.5	3.5				
4	-3.5	4.3	3.1	0.9				
C(FIX)/C(IN)								
32	-1.4	5.9						
64	-3.6	4.7						

LEADTIME	C(FIX)/C(IN)		
2	32	-0.5	6.6
2	64	-2.4	6.2
4	32	-2.2	5.3
4	64	-4.7	3.4

Table K17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -1.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	1.6	-4.4	-4.9	2.8	-1.2	-0.7	1.2	-2.6
MEAN								
8	6.3	-5.2	-4.8	7.0	3.3	-0.5		
16	-1.7	-3.7	-5.1	-0.2	-4.6	-0.9		
LEADTIME								
2	1.0	-4.1	-4.4	1.8				
4	2.2	-4.6	-5.4	3.7				
C(FIX)/C(IN)								
32	-0.6	-10.4						
64	3.8	1.6						

LEADTIME	C(FIX)/C(IN)		
2	32	-2.0	-7.4
2	64	3.8	-0.9
4	32	0.5	-13.0
4	64	3.8	3.7

Table K18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.0	-6.4	-1.1	-0.2	-1.7	0.6	2.7	-2.7
MEAN								
8	8.7	-2.8	0.9	3.9	1.5	3.9		
16	4.1	-8.8	-2.5	-2.9	-3.8	-1.6		
LEADTIME								
2	4.7	-7.4	-2.0	-1.5				
4	7.2	-5.3	-0.1	1.1				
C(FIX)/C(IN)								
32	5.8	-7.2						
64	6.0	-5.8						

LEADTIME	C(FIX)/C(IN)		
2	32	5.3	-8.4
2	64	4.4	-6.7
4	32	6.4	-5.9
4	64	7.8	-4.8

Table K19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 1.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	1.6	-6.2	-0.7	3.2	0.7	1.7	4.7	-2.3
MEAN								
8	5.3	-6.4	2.9	6.6	5.8	3.7		
16	-2.1	-6.0	-4.3	-0.3	-4.3	-0.2		
LEADTIME								
2	1.1	-5.9	-1.5	3.0				
4	2.1	-6.5	0.1	3.3				
C(FIX)/C(IN)								
32	-0.2	-11.5						
64	3.3	-0.9						

LEADTIME	C(FIX)/C(IN)		
2	32	-1.1	-9.0
2	64	3.3	-2.8
4	32	0.7	-14.1
4	64	3.4	1.1

Table K20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -1.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		1.6	-4.4	-4.9	2.8	-1.2	-0.7	1.2	-2.6
MEAN									
8		6.3	-5.2	-4.8	7.0	3.3	-0.5		
16		-1.7	-3.7	-5.1	-0.2	-4.6	-0.9		
LEADTIME									
2		1.0	-4.1	-4.4	1.8				
4		2.2	-4.6	-5.4	3.7				
C(FIX)/C(IN)									
32		-0.6	-10.4						
64		3.8	1.6						
LEADTIME	C(FIX)/C(IN)								
2	32	-2.0	-7.4						
2	64	3.6	-0.9						
4	32	0.5	-13.0						
4	64	3.8	3.7						

Table K21

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		5.9	-6.6	-1.1	-0.2	-1.7	0.4	2.2	-2.6
MEAN									
8		8.6	-3.6	0.9	3.9	1.2	3.2		
16		4.1	-8.6	-2.5	-2.9	-3.8	-1.5		
LEADTIME									
2		4.9	-7.7	-2.0	-1.5				
4		7.0	-5.5	-0.1	1.1				
C(FIX)/C(IN)									
32		5.8	-7.2						
64		6.0	-5.8						
LEADTIME	C(FIX)/C(IN)								
2	32	5.3	-8.4						
2	64	4.4	-6.7						
4	32	6.4	-5.9						
4	64	7.8	-4.8						

Appendix L

Multi-item Data for the (24,24) Statistical Power Approximation

Model I

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information from a 24-Period Demand History, with Revision Every 24 Periods, Using Regression Estimates of Demand Means and Variances.

		page
Table L1	Sources of Total Cost	L1
L3	Sources of Aggregate Period-End Inventory	L2
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L6	Backlog Frequency	L5
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L19	Backlog Frequency (% Excess Over DP)	L12
L20	Weighted Proportion of Demand Backlogged (% Excess (Over DP)	L13
L21	Replenishment Frequency (% Excess Over DP)	L14

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices K and L.

Table L1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 810.5

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		37.3	62.7	45.6	54.4	46.8	53.2	42.1	57.9
MEAN									
	8	15.6	26.5	19.2	22.9	19.7	22.4		
	16	21.7	36.1	26.4	31.5	27.1	30.8		
LEADTIME									
	2	17.7	29.1	21.1	25.7				
	4	19.6	33.6	24.5	28.7				
C(FIX)/C(IN)									
	32	16.6	29.0						
	64	20.8	33.6						

LEADTIME	C(FIX)/C(IN)		
2	32	7.8	13.3
2	64	10.0	15.8
4	32	8.8	15.7
4	64	10.8	17.9

Table L3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 472.7 PERCENT OF TOTAL COST= 58.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.8	71.2	47.5	52.5	45.9	54.1	42.0	58.0
MEAN									
8		11.8	30.1	20.1	21.9	19.3	22.6		
16		17.0	41.0	27.4	30.6	26.5	31.5		
LEADTIME									
2		13.3	32.6	21.5	24.4				
4		15.6	38.6	26.0	28.1				
C(FIX)/C(IN)									
32		13.4	34.1						
64		15.4	37.1						
LEADTIME	C(FIX)/C(IN)								
2	32	6.0	15.5						
2	64	7.2	17.1						
4	32	7.4	18.6						
4	64	8.2	19.9						

Table L4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 130.3 PERCENT OF TOTAL COST= 16.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		47.3	52.7	48.0	52.0	44.1	55.9	43.6	56.4
MEAN									
	8	20.6	23.0	20.5	23.2	19.1	24.5		
	16	26.6	29.7	27.6	28.8	25.0	31.4		
LEADTIME									
	2	21.4	22.7	21.0	23.1				
	4	25.8	30.0	27.0	28.9				
C(FIX)/C(IN)									
	32	22.4	25.6						
	64	24.9	27.1						

LEADTIME	C(FIX)/C(IN)		
2	32	10.1	10.9
2	64	11.3	11.8
4	32	12.3	14.7
4	64	13.6	15.4

Table L5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 207.6 PERCENT OF TOTAL COST= 25.6

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	50.4	49.6	39.7	60.3	50.8	49.2	41.5	58.5
MEAN								
8	21.0	20.6	16.6	24.9	21.0	20.5		
16	29.4	29.0	23.1	35.3	29.8	28.7		
LEADTIME								
2	25.6	25.2	20.3	30.5				
4	24.8	24.4	19.5	29.8				
C(FIX)/C(IN)								
32	20.1	19.7						
64	30.3	29.9						

LEADTIME	C(FIX)/C(IN)		
2	32	10.2	10.0
2	64	15.4	15.1
4	32	9.9	9.6
4	64	15.0	14.8

Table L6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1013

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1903	0.0123	0.0996	0.1029	0.1009	0.1017	0.1030	0.0996
MEAN									
8		0.1937	0.0122	0.1006	0.1053	0.1022	0.1037		
16		0.1868	0.0123	0.0986	0.1005	0.0995	0.0997		
LEADTIME									
2		0.1901	0.0117	0.0992	0.1025				
4		0.1905	0.0129	0.1000	0.1033				
C(FIX)/C(IN)									
32		0.1872	0.0120						
64		0.1933	0.0125						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1871	0.0113						
2	64	0.1930	0.0120						
4	32	0.1873	0.0127						
4	64	0.1936	0.0131						

Table L7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0132

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1603	0.0072	0.0127	0.0137	0.0116	0.0147	0.0172	0.0111
MEAN									
	8	0.2099	0.0095	0.0162	0.0183	0.0151	0.0194		
	16	0.1355	0.0061	0.0109	0.0114	0.0099	0.0124		
LEADTIME									
	2	0.1452	0.0062	0.0111	0.0122				
	4	0.1754	0.0082	0.0142	0.0152				
C(FIX)/C(IN)									
	32	0.1519	0.0070						
	64	0.1687	0.0074						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1370	0.0060
2	64	0.1534	0.0064
4	32	0.1668	0.0080
4	64	0.1839	0.0084

Table L8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2833

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2857	0.2808	0.3223	0.2442	0.2879	0.2786	0.2356	0.3309
MEAN									
	8	0.2381	0.2332	0.2694	0.2019	0.2382	0.2331		
	16	0.3333	0.3284	0.3752	0.2866	0.3376	0.3241		
LEADTIME									
	2	0.2903	0.2855	0.3286	0.2472				
	4	0.2811	0.2761	0.3159	0.2413				
C(FIX)/C(IN)									
	32	0.3255	0.3191						
	64	0.2459	0.2425						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3315	0.3258
2	64	0.2492	0.2452
4	32	0.3195	0.3123
4	64	0.2427	0.2399

Table L15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 8.6

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	4.8	10.9	9.3	7.9	7.5	9.5	9.2	8.1
MEAN								
8	5.3	11.6	9.7	8.8	8.0	10.2		
16	4.4	10.4	9.1	7.3	7.1	9.0		
LEADTIME								
2	4.0	9.8	7.9	7.2				
4	5.6	11.9	10.6	8.6				
C(FIX)/C(IN)								
32	5.2	11.8						
64	4.4	10.2						

LEADTIME	C(FIX)/C(IN)		
2	32	4.0	10.3
2	64	3.9	9.4
4	32	6.3	13.1
4	64	5.0	10.9

Table L16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 9.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	4.6	11.2	10.3	8.3	9.1	9.3	8.2	9.9
MEAN								
8	2.5	10.6	10.7	6.0	8.3	8.1		
16	6.1	11.6	9.9	9.9	9.7	10.1		
LEADTIME								
2	3.4	11.6	9.5	8.8				
4	5.7	10.8	10.9	7.8				
C(FIX)/C(IN)								
32	6.3	11.9						
64	3.3	10.5						

LEADTIME	C(FIX)/C(IN)		
2	32	4.0	11.9
2	64	2.9	11.4
4	32	8.2	12.0
4	64	3.5	9.7

Table L17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 23.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		2.5	50.5	21.5	24.8	19.4	26.4	25.3	21.6
MEAN									
8		5.6	50.6	20.0	30.5	20.4	29.5		
16		0.2	50.4	22.6	20.6	18.6	24.1		
LEADTIME									
2		2.1	41.9	16.8	21.7				
4		2.8	57.6	25.4	27.4				
C(FIX)/C(IN)									
32		1.2	47.4						
64		3.7	53.5						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1	38.1						
2	64	4.0	45.7						
4	32	2.0	55.1						
4	64	3.5	60.1						

Table L18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.4	-6.2	-0.5	-0.1	-0.8	0.4	2.6	-2.2
MEAN								
8	9.0	-3.1	0.7	4.0	1.5	3.8		
16	4.7	-8.2	-1.2	-2.8	-2.5	-1.9		
LEADTIME								
2	5.6	-6.6	-0.5	-1.1				
4	7.3	-5.7	-0.4	1.0				
C(FIX)/C(IN)								
32	6.7	-6.8						
64	6.3	-5.7						

LEADTIME	C(FIX)/C(IN)		
2	32	6.8	-6.9
2	64	4.8	-6.5
4	32	6.6	-6.7
4	64	7.7	-5.0

Table L19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-0.8	32.9	-0.7	2.1	0.6	0.8	3.0	-1.5
MEAN								
8	1.5	34.5	0.8	5.1	2.6	3.4		
16	-3.1	31.3	-2.2	-0.9	-1.4	-1.7		
LEADTIME								
2	-0.7	27.1	-1.0	2.2				
4	-1.0	38.6	-0.3	2.0				
C(FIX)/C(IN)								
32	-2.2	30.1						
64	0.5	35.7						

LEADTIME	C(FIX)/C(IN)		
2	32	-2.2	23.6
2	64	0.9	30.6
4	32	-2.1	36.4

Table L20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 23.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		2.5	50.5	21.5	24.8	19.4	26.4	25.3	21.6
MEAN									
8		5.6	50.6	20.0	30.5	20.4	29.5		
16		0.2	50.4	22.6	20.6	18.6	24.1		
LEADTIME									
2		2.1	41.9	16.8	21.7				
4		2.8	57.6	25.4	27.4				
C(FIX)/C(IN)									
32		1.2	47.4						
64		3.7	53.5						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1	38.1						
2	64	4.0	45.7						
4	32	2.0	55.1						
4	64	3.5	60.1						

Table L21

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		6.5	-6.4	-0.5	-0.1	-0.7	0.2	2.1	-1.9
MEAN									
8		8.9	-4.1	0.7	4.0	1.1	3.0		
16		4.9	-7.9	-1.2	-2.8	-2.0	-1.8		
LEADTIME									
2		5.9	-6.7	-0.5	-1.1				
4		7.1	-6.0	-0.4	1.0				
C(FIX)/C(IN)									
32		6.7	-6.8						
64		6.3	-5.7						
LEADTIME	C(FIX)/C(IN)								
2	32	6.8	-6.9						
2	64	4.8	-6.5						
4	32	6.6	-6.7						
4	64	7.7	-5.0						

Appendix M

Multi-item Forecasts for the (24,24) Statistical Power Approximation

Model I

Forecasting Properties of Inventory System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information, Revision Taking Place Every 24 Periods Using a 24-Period Demand History and Regression Estimates of Demand Means and Variances. Forecasts Made at Each Revision Using a 24-Period Demand History.

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M4	Sources of Forecast of Aggregate Replenishment Cost	M4
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M19	Weighted Proportion of Demand Backlogged (% Underestimate of Actual by Forecast)	M19
M20	Replenishment Frequency (% Underestimate of Actual by Forecast)	M20

Note: The corresponding appendices in MacCormick (1974), are his Appendices T and U.

Table M1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 737.6

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		39.2	60.8	45.1	54.9	48.0	52.0	41.9	58.1
MEAN									
8		16.4	25.5	18.9	23.0	20.1	21.8		
16		22.8	35.3	26.2	31.9	27.9	30.2		
LEADTIME									
2		18.9	29.1	21.5	26.5				
4		20.3	31.7	23.6	28.4				
C(FIX)/C(IN)									
32		17.2	27.9						
64		22.0	32.9						
LEADTIME	C(FIX)/C(IN)								
2	32	8.3	13.3						
2	64	10.6	15.8						
4	32	8.9	14.7						
4	64	11.3	17.1						

Table M2

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 454.0 PERCENT OF TOTAL COST= 61.6

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	28.2	71.8	47.4	52.6	46.2	53.8	42.0	58.0
MEAN								
8	11.6	30.3	19.9	22.1	19.4	22.5		
16	16.6	41.4	27.4	30.6	26.8	31.2		
LEADTIME								
2	13.2	33.0	21.7	24.6				
4	15.0	38.8	25.7	28.1				
C(FIX)/C(IN)								
32	13.0	34.3						
64	15.2	37.4						

LEADTIME	C(FIX)/C(IN)		
2	32	6.0	15.6
2	64	7.2	17.4
4	32	7.0	18.7
4	64	8.0	20.1

Table M3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 74.7 PERCENT OF TOTAL COST= 10.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		74.5	25.5	46.4	53.6	51.3	48.7	42.3	57.7
MEAN									
	8	32.4	9.9	19.4	22.9	21.8	20.5		
	16	42.1	15.6	27.0	30.7	29.5	28.2		
LEADTIME									
	2	34.9	16.4	24.3	27.0				
	4	39.5	9.2	22.1	26.6				
C(FIX)/C(IN)									
	32	34.6	11.8						
	64	39.8	13.8						

LEADTIME	C(FIX)/C(IN)		
2	32	16.5	7.8
2	64	18.5	8.6
4	32	18.1	4.0
4	64	21.4	5.2

Table M4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 208.9 PERCENT OF TOTAL COST= 28.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.4	49.6	39.8	60.2	50.7	49.3	41.5	58.5
MEAN									
	8	21.0	20.6	16.6	24.9	21.0	20.6		
	16	29.4	29.1	23.2	35.3	29.7	28.8		
LEADTIME									
	2	25.5	25.1	20.3	30.4				
	4	24.8	24.5	19.5	29.8				
C(FIX)/C(IN)									
	32	20.1	19.7						
	64	30.3	29.9						

LEADTIME	C(FIX)/C(IN)		
2	32	10.2	10.1
2	64	15.3	15.1
4	32	9.8	9.7
4	64	15.0	14.8

Table M5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.0961

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	0.1871	0.0051	0.0941	0.0981	0.0980	0.0942	0.0969	0.0953
MEAN								
8	0.1891	0.0048	0.0946	0.0992	0.0990	0.0949		
16	0.1851	0.0055	0.0935	0.0970	0.0971	0.0934		
LEADTIME								
2	0.1898	0.0063	0.0972	0.0989				
4	0.1844	0.0040	0.0910	0.0973				
C(FIX)/C(IN)								
32	0.1838	0.0044						
64	0.1904	0.0059						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1891	0.0053
2	64	0.1905	0.0073
4	32	0.1785	0.0034
4	64	0.1902	0.0045

Table M6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0076

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
MEAN	0.1448	0.0020	0.0070	0.0081	0.0077	0.0074	0.0096	0.0065
8	0.1888	0.0023	0.0088	0.0104	0.0099	0.0093		
16	0.1228	0.0018	0.0061	0.0070	0.0067	0.0064		
LEADTIME								
2	0.1359	0.0026	0.0073	0.0082				
4	0.1536	0.0014	0.0067	0.0080				
C(FIX)/C(IN)								
32	0.1346	0.0019						
64	0.1550	0.0022						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1281	0.0024
2	64	0.1437	0.0027
4	32	0.1410	0.0013
4	64	0.1662	0.0016

Table M7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2852

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.2873	0.2831	0.3247	0.2456	0.2894	0.2810	0.2373	0.3331
	8	0.2396	0.2349	0.2710	0.2035	0.2393	0.2353		
	16	0.3349	0.3313	0.3785	0.2878	0.3396	0.3267		
LEADTIME									
	2	0.2915	0.2873	0.3310	0.2479				
	4	0.2831	0.2789	0.3185	0.2434				
C(FIX)/C(IN)									
	32	0.3274	0.3221						
	64	0.2472	0.2441						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3334	0.3285
2	64	0.2496	0.2461
4	32	0.3214	0.3156
4	64	0.2448	0.2421

Table M8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF VARIANCE OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 1159.5

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		16.1	83.9	48.2	51.8	47.6	52.4	37.7	62.3
MEAN									
8		6.6	31.1	19.2	18.6	18.2	19.6		
16		9.5	52.8	29.0	33.2	29.5	32.8		
LEADTIME									
2		5.3	42.4	23.3	24.3				
4		10.8	41.5	24.9	27.5				
C(FIX)/C(IN)									
32		8.0	40.2						
64		8.1	43.7						
LEADTIME	C(FIX)/C(IN)								
2	32	2.5	20.9						
2	64	2.8	21.5						
4	32	5.5	19.3						
4	64	5.3	22.2						

Table M9

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 34.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		13.7	31.2	23.6	24.5	23.5	24.6	20.9	26.9
MEAN									
8		8.8	19.0	14.9	14.7	14.5	15.1		
16		10.5	24.7	18.4	19.6	18.5	19.5		
LEADTIME									
2		7.8	22.2	16.5	16.8				
4		11.2	21.9	17.0	17.9				
C(FIX)/C(IN)									
32		9.6	21.6						
64		9.7	22.5						
LEADTIME	C(FIX)/C(IN)								
2	32	5.4	15.6						
2	64	5.7	15.8						
4	32	8.0	15.0						
4	64	7.8	16.0						

Table M10

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 21.2

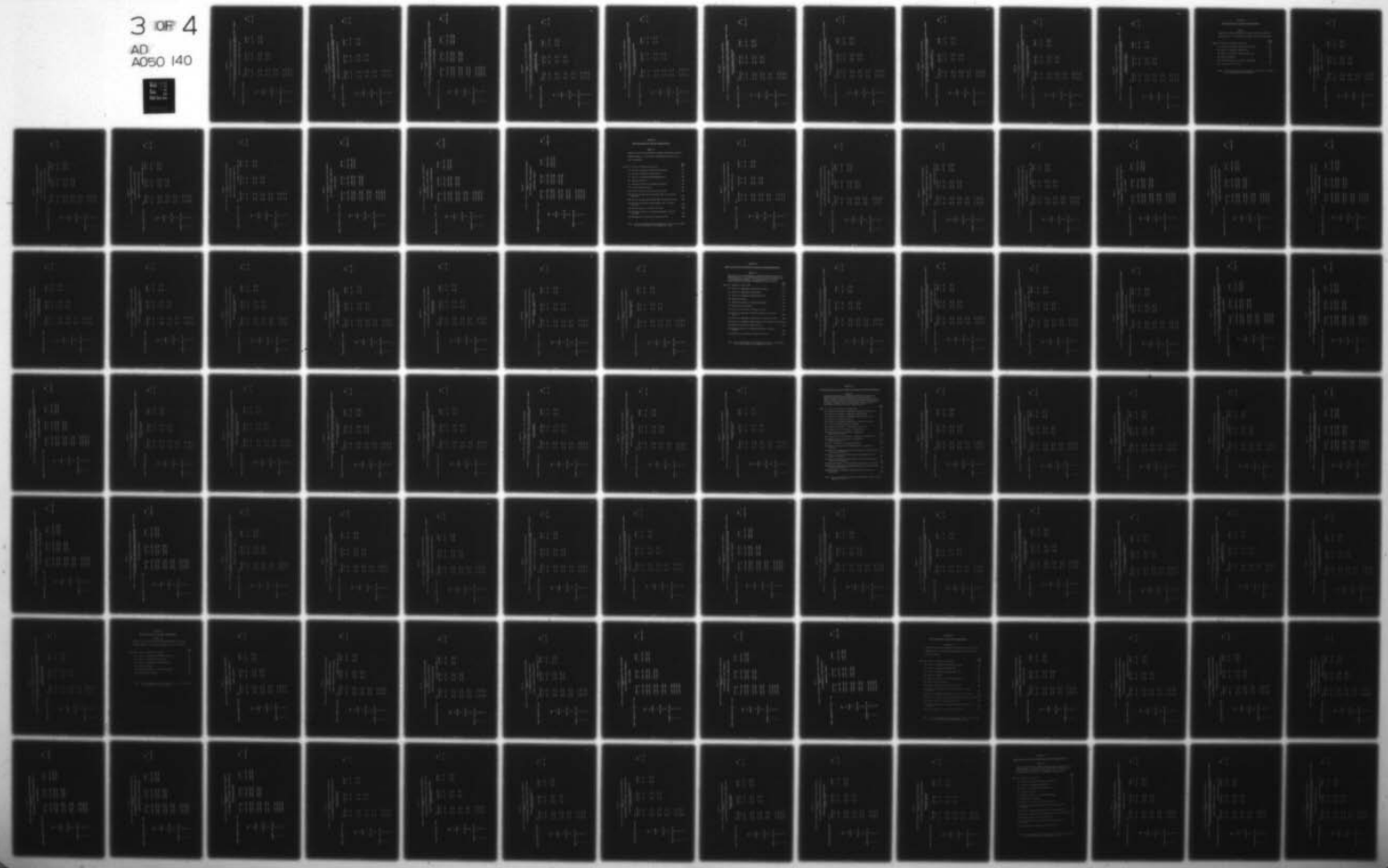
	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	7.1	20.0	15.1	14.9	12.8	16.9	13.8	16.1
MEAN								
8	4.6	13.0	9.8	9.8	8.5	10.9		
16	5.4	15.2	11.6	11.2	9.6	12.9		
LEADTIME								
2	4.1	12.1	9.1	9.0				
4	5.8	15.9	12.1	11.8				
C(FIX)/C(IN)								
32	5.0	14.3						
64	5.1	14.0						

LEADTIME	C(FIX)/C(IN)		
2	32	2.8	8.7
2	64	3.1	8.5
4	32	4.2	11.3
4	64	4.0	11.1

AD-A050 140 NORTH CAROLINA UNIV AT CHAPEL HILL GRADUATE SCHOOL OF--ETC F/G 15/5
(S,S) INVENTORY POLICIES IN A NONSTATIONARY DEMAND ENVIRONMENT.--ETC(U)
APR 77 R L KAUFMAN. DAAG29-76-G-0323

UNCLASSIFIED TR-11-APP ARO-14635.1-M-APP NL

3 OF 4
AD
A050 140



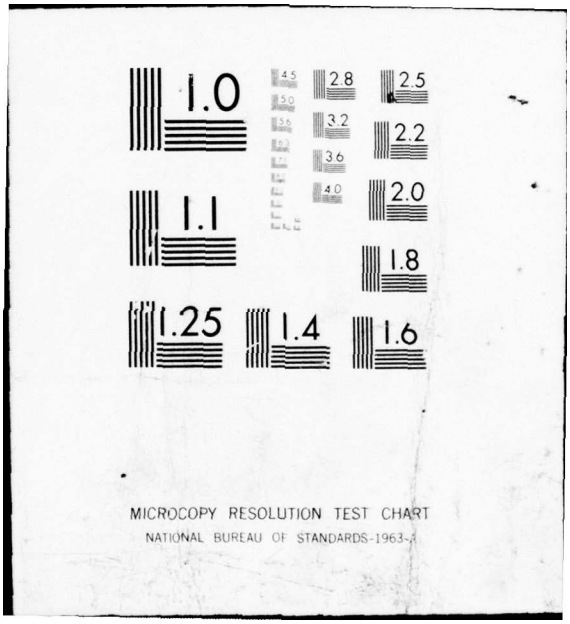

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Table M11

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 26.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		10.2	23.9	18.5	18.3	19.7	17.0	15.1	21.2
MEAN									
8		6.4	13.7	10.8	10.5	11.6	9.6		
16		8.0	19.6	15.0	15.0	15.9	14.0		
LEADTIME									
2		5.9	18.9	14.2	13.7				
4		8.4	14.7	11.8	12.1				
C(FIX)/C(IN)									
32		7.2	17.0						
64		7.2	16.8						
LEADTIME	C(FIX)/C(IN)								
2	32	4.0	13.6						
2	64	4.3	13.0						
4	32	6.0	10.2						
4	64	5.8	10.7						

Table M12

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 5.6

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	3.9	4.1	3.2	4.7	4.1	3.9	3.8	4.2
MEAN								
8	2.6	2.8	2.0	3.2	2.7	2.7		
16	2.9	3.0	2.5	3.4	3.0	2.9		
LEADTIME								
2	2.8	2.9	2.4	3.3				
4	2.7	2.8	2.0	3.4				
C(FIX)/C(IN)								
32	2.2	2.3						
64	3.2	3.4						

LEADTIME	C(FIX)/C(IN)		
2	32	1.6	1.8
2	64	2.3	2.3
4	32	1.5	1.4
4	64	2.3	2.4

Table M13

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

S.D. OF BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1727

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1678	0.0407	0.1258	0.1183	0.1185	0.1256	0.1237	0.1205
MEAN									
	8	0.1205	0.0280	0.0889	0.0860	0.0871	0.0878		
	16	0.1169	0.0295	0.0891	0.0812	0.0803	0.0899		
LEADTIME									
	2	0.1144	0.0309	0.0832	0.0843				
	4	0.1228	0.0264	0.0944	0.0829				
C(FIX)/C(IN)									
	32	0.1228	0.0274						
	64	0.1144	0.0301						

LEADTIME	C(FIX)/C(IN)		
2	32	0.0807	0.0205
2	64	0.0811	0.0232
4	32	0.0926	0.0182
4	64	0.0807	0.0192

Table M14

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 9.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	4.5	11.7	10.0	8.2	6.8	11.0	9.6	8.6
MEAN								
8	4.5	12.5	10.6	8.7	7.3	11.6		
16	4.5	11.1	9.5	7.8	6.4	10.6		
LEADTIME								
2	2.9	9.1	7.2	6.4				
4	5.9	13.9	12.3	9.8				
C(FIX)/C(IN)								
32	5.5	12.5						
64	3.7	11.0						

LEADTIME	C(FIX)/C(IN)		
2	32	3.2	9.6
2	64	2.8	8.7
4	32	7.5	15.0
4	64	4.6	13.0

Table M15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 4.0

	C(CUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.1	3.1	4.3	3.7	3.2	4.6	4.0	3.9
MEAN								
8	5.8	3.3	4.8	3.4	3.5	4.4		
16	6.2	3.0	3.9	3.9	3.0	4.7		
LEADTIME								
2	4.2	2.8	3.3	3.2				
4	7.6	3.4	5.1	4.2				
C(FIX)/C(IN)								
32	6.8	3.3						
64	5.4	3.0						

LEADTIME	C(FIX)/C(IN)		
2	32	4.4	2.9
2	64	4.0	2.8
4	32	8.7	3.6
4	64	6.7	3.1

Table M16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 42.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	9.7	72.2	44.6	40.9	33.3	50.1	44.5	41.3
MEAN								
8	10.0	75.3	45.7	43.4	34.7	52.0		
16	9.4	69.9	43.8	38.9	32.2	48.5		
LEADTIME								
2	6.4	58.7	33.9	32.8				
4	12.4	82.5	53.0	47.3				
C(FIX)/C(IN)								
32	11.4	73.6						
64	8.1	70.9						

LEADTIME	C(FIX)/C(IN)		
2	32	6.5	59.2
2	64	6.3	58.2
4	32	15.5	84.4
4	64	9.6	80.6

Table M17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= -0.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-0.5	-0.8	-0.8	-0.6	-0.4	-0.9	-0.7	-0.6
MEAN								
8	-0.6	-0.8	-0.6	-0.8	-0.6	-0.9		
16	-0.5	-0.7	-0.9	-0.4	-0.4	-0.8		
LEADTIME								
2	-0.3	-0.6	-0.7	-0.3				
4	-0.8	-1.0	-0.8	-0.9				
C(FIX)/C(IN)								
32	-0.6	-0.9						
64	-0.5	-0.6						

LEADTIME	C(FIX)/C(IN)		
2	32	-0.6	-0.8
2	64	-0.2	-0.4
4	32	-0.6	-1.1
4	64	-0.9	-0.9

Table M18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 5.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	1.7	58.2	5.6	4.7	2.8	7.4	5.9	4.3
MEAN								
8	2.4	60.9	6.0	5.8	3.2	8.5		
16	0.9	55.5	5.1	3.5	2.4	6.2		
LEADTIME								
2	0.1	46.0	2.0	3.5				
4	3.2	69.2	9.0	5.8				
C(FIX)/C(IN)								
32	1.8	63.6						
64	1.5	53.0						

LEADTIME	C(FIX)/C(IN)		
2	32	-1.0	53.1
2	64	1.3	39.2
4	32	4.7	72.9
4	64	1.7	65.7

Table M19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 42.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	9.7	72.2	44.6	40.9	33.3	50.1	44.5	41.3
MEAN								
8	10.0	75.3	45.7	43.4	34.7	52.0		
16	9.4	69.9	43.8	38.9	32.2	48.5		
LEADTIME								
2	6.4	58.7	33.9	32.8				
4	12.4	82.5	53.0	47.3				
C(FIX)/C(IN)								
32	11.4	73.6						
64	8.1	70.9						

LEADTIME	C(FIX)/C(IN)		
2	32	6.5	59.2
2	64	6.3	58.2
4	32	15.5	89.4
4	64	9.6	80.6

Table M20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= -0.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-0.6	-0.8	-0.8	-0.6	-0.5	-0.9	-0.7	-0.7
MEAN								
8	-0.7	-0.7	-0.6	-0.8	-0.4	-0.9		
16	-0.5	-0.9	-0.9	-0.4	-0.6	-0.8		
LEADTIME								
2	-0.4	-0.6	-0.7	-0.3				
4	-0.7	-1.0	-0.8	-0.9				
C(FIX)/C(IN)								
32	-0.6	-0.9						
64	-0.5	-0.6						

LEADTIME	C(FIX)/C(IN)		
2	32	-0.6	-0.8
2	64	-0.2	-0.4
4	32	-0.6	-1.1
4	64	-0.9	-0.9

Appendix N

Multi-item Data for the Power Approximation

Model II

System of 16 Items with Negative Binomial Demand Distributions

(Variance/Mean = 3) Controlled Optimally with Full Information.

		page
Table N1	Sources of Expected Total Cost	N1
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Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendix C.

Table N1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, OPTIMAL CONTROL (DP)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 751.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.7	61.3	45.3	54.7	47.3	52.7	41.8	58.2
MEAN									
8		16.0	25.8	19.0	22.8	19.8	22.0		
16		22.6	35.6	26.3	31.9	27.5	30.6		
LEADTIME									
2		18.5	28.8	21.2	26.1				
4		20.1	32.5	24.0	28.7				
C(FIX)/C(IN)									
32		17.1	28.2						
64		21.6	33.2						
LEADTIME	C(FIX)/C(IN)								
2	32	8.1	13.1						
2	64	10.4	15.7						
4	32	9.0	15.0						
4	64	11.2	17.5						

Table N3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 437.6 PERCENT OF TOTAL COST= 58.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		30.1	69.9	46.9	53.1	46.0	54.0	42.1	57.9
MEAN									
8		12.5	29.6	19.7	22.4	19.4	22.7		
16		17.5	40.3	27.1	30.8	26.6	31.3		
LEADTIME									
2		14.0	32.0	21.4	24.6				
4		16.1	37.9	25.5	28.5				
C(FIX)/C(IN)									
32		13.6	33.2						
64		16.4	36.7						
LEADTIME	C(FIX)/C(IN)								
2	32	6.3	15.1						
2	64	7.7	16.9						
4	32	7.4	18.1						
4	64	8.7	19.8						

Table N4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 106.4 PERCENT OF TOTAL COST= 14.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		56.8	43.2	48.7	51.3	45.6	54.4	42.8	57.2
MEAN									
8		23.9	18.8	21.0	21.8	19.5	23.3		
16		32.9	24.4	27.8	29.5	26.1	31.1		
LEADTIME									
2		25.9	19.7	22.1	23.4				
4		30.9	23.5	26.6	27.8				
C(FIX)/C(IN)									
32		27.3	21.4						
64		29.5	21.8						
LEADTIME	C(FIX)/C(IN)								
2	32	12.3	9.8						
2	64	13.6	9.9						
4	32	15.0	11.6						
4	64	15.9	11.9						

Table N5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 207.8 PERCENT OF TOTAL COST= 27.6

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		47.5	52.5	40.1	59.9	51.0	49.0	40.7	59.3
MEAN									
8		19.5	21.3	16.4	24.3	20.8	20.0		
16		28.0	31.2	23.7	35.5	30.2	29.1		
LEADTIME									
2		24.3	26.7	20.5	30.5				
4		23.2	25.9	19.6	29.4				
C(FIX)/C(IN)									
32		19.1	21.0						
64		28.4	31.5						
LEADTIME	C(FIX)/C(IN)								
2	32	9.8	10.7						
2	64	14.5	16.0						
4	32	9.3	10.4						
4	64	13.9	15.5						

Table N6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, OPTIMAL CONTROL(DP)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1005

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1918	0.0092	0.1005	0.1005	0.1002	0.1008	0.0998	0.1012
MEAN									
	8	0.1906	0.0091	0.0999	0.0998	0.0994	0.1003		
	16	0.1930	0.0093	0.1010	0.1013	0.1010	0.1013		
LEADTIME									
	2	0.1913	0.0091	0.0997	0.1007				
	4	0.1923	0.0093	0.1012	0.1004				
C(FIX)/C(IN)									
	32	0.1917	0.0092						
	64	0.1918	0.0092						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1903	0.0092
2	64	0.1922	0.0091
4	32	0.1932	0.0092
4	64	0.1914	0.0093

Table N7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, OPTIMAL CONTROL(DP)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0108

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1575	0.0048	0.0105	0.0110	0.0098	0.0117	0.0138	0.0092
MEAN									
8		0.1991	0.0063	0.0135	0.0141	0.0126	0.0151		
16		0.1367	0.0041	0.0090	0.0095	0.0084	0.0100		
LEADTIME									
2		0.1436	0.0044	0.0095	0.0101				
4		0.1714	0.0053	0.0114	0.0120				
C(FIX)/C(IN)									
32		0.1514	0.0048						
64		0.1635	0.0049						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1365	0.0044						
2	64	0.1506	0.0044						
4	32	0.1664	0.0052						
4	64	0.1765	0.0053						

Table N8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, OPTIMAL CONTROL(DP)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2844

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2701	0.2986	0.3257	0.2430	0.2900	0.2787	0.2320	0.3367
MEAN									
	8	0.2212	0.2428	0.2664	0.1976	0.2368	0.2271		
	16	0.3190	0.3545	0.3850	0.2885	0.3432	0.3303		
LEADTIME									
	2	0.2769	0.3031	0.3325	0.2475				
	4	0.2633	0.2941	0.3188	0.2386				
C(FIX)/C(IN)									
	32	0.3098	0.3416						
	64	0.2304	0.2557						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3184	0.3467
2	64	0.2353	0.2596
4	32	0.3012	0.3365
4	64	0.2255	0.2517

Appendix O

Multi-item Data for the Power Approximation

Model II

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled Approximately Optimally with Full Information.

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07	Weighted Proportion of Demand Backlogged	06
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015	Sources of Total Cost (% Excess Over DP)	08
016	Sources of Aggregate Period-End Inventory (% Excess Over DP)	09
017	Sources of Aggregate Backlog Cost (% Excess Over DP)	010
018	Sources of Aggregate Replenishment Cost (% Excess Over DP)	011
019	Backlog Frequency (% Excess Over DP)	012
020	Weighted Proportion of Demand Backlogged (% Excess Over DP)	013
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Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices E and F.

Table 01

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 757.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.6	61.4	45.2	54.8	47.3	52.7	41.9	58.1
MEAN									
8		16.1	25.8	19.0	22.9	19.8	22.1		
16		22.5	35.6	26.2	31.9	27.5	30.6		
LEADTIME									
2		18.5	28.8	21.2	26.1				
4		20.1	32.6	24.0	28.7				
C(FIX)/C(IN)									
32		17.0	28.2						
64		21.6	33.2						
LEADTIME	C(FIX)/C(IN)								
2	32	8.1	13.1						
2	64	10.4	15.7						
4	32	9.0	15.0						
4	64	11.2	17.5						

Table 03

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 442.5 PERCENT OF TOTAL COST= 58.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.4	71.6	47.4	52.6	46.1	53.9	41.7	58.3
MEAN									
	8	11.5	30.2	19.7	22.0	19.1	22.6		
	16	16.9	41.4	27.7	30.6	26.9	31.3		
LEADTIME									
	2	13.3	32.8	21.6	24.5				
	4	15.2	38.8	25.8	28.1				
C(FIX)/C(IN)									
	32	13.2	34.2						
	64	15.3	37.3						
LEADTIME	C(FIX)/C(IN)								
2	32	6.1	15.5						
2	64	7.2	17.3						
4	32	7.1	18.7						
4	64	8.1	20.0						

Table 04

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 106.2 PERCENT OF TOTAL COST= 14.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		58.2	41.8	46.5	53.5	46.0	54.0	43.4	56.6
MEAN									
8		25.6	17.8	20.3	23.1	20.4	23.0		
16		32.6	24.0	26.2	30.4	25.6	31.0		
LEADTIME									
2		26.6	19.4	21.7	24.3				
4		31.7	22.4	24.8	29.2				
C(FIX)/C(IN)									
32		27.2	19.3						
64		31.0	22.5						
LEADTIME	C(FIX)/C(IN)								
2	32	12.4	9.3						
2	64	14.2	10.1						
4	32	14.8	10.0						
4	64	16.8	12.4						

Table 05

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 208.9 PERCENT OF TOTAL COST= 27.6

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.2	49.8	39.8	60.2	50.6	49.4	41.5	58.5
MEAN									
	8	20.8	20.7	16.7	24.8	21.0	20.5		
	16	29.4	29.1	23.1	35.4	29.6	28.9		
LEADTIME									
	2	25.4	25.2	20.2	30.4				
	4	24.8	24.6	19.6	29.8				
C(FIX)/C(IN)									
	32	20.0	19.8						
	64	30.2	30.0						
LEADTIME	C(FIX)/C(IN)								
2	32	10.2	10.0						
2	64	15.3	15.2						
4	32	9.9	9.7						
4	64	14.9	14.8						

Table 06

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1028

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
	MEAN	0.1969	0.0088	0.1005	0.1051	0.1029	0.1028	0.1053	0.1003
	8	0.2021	0.0085	0.1037	0.1070	0.1068	0.1039		
	16	0.1916	0.0090	0.0974	0.1033	0.0990	0.1017		
	LEADTIME								
	2	0.1969	0.0089	0.1007	0.1051				
	4	0.1969	0.0087	0.1004	0.1052				
	C(FIX)/C(IN)								
	32	0.1928	0.0083						
	64	0.2010	0.0093						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1927	0.0086						
2	64	0.2010	0.0091						
4	32	0.1928	0.0079						
4	64	0.2010	0.0094						

Table 07

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0107

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1611	0.0047	0.0100	0.0115	0.0099	0.0116	0.0140	0.0091
MEAN									
8		0.2127	0.0060	0.0131	0.0149	0.0132	0.0148		
16		0.1353	0.0040	0.0084	0.0098	0.0082	0.0100		
LEADTIME									
2		0.1471	0.0043	0.0093	0.0105				
4		0.1751	0.0050	0.0107	0.0125				
C(FIX)/C(IN)									
32		0.1506	0.0043						
64		0.1716	0.0050						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1370	0.0041						
2	64	0.1572	0.0045						
4	32	0.1642	0.0045						
4	64	0.1859	0.0055						

Table 08

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2853

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2866	0.2839	0.3249	0.2456	0.2891	0.2814	0.2374	0.3331
MEAN									
	8	0.2385	0.2363	0.2722	0.2026	0.2410	0.2339		
	16	0.3348	0.3314	0.3775	0.2886	0.3373	0.3288		
LEADTIME									
	2	0.2906	0.2877	0.3299	0.2484				
	4	0.2827	0.2801	0.3198	0.2429				
C(FIX)/C(IN)									
	32	0.3268	0.3229						
	64	0.2465	0.2448						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3320	0.3279
2	64	0.2493	0.2475
4	32	0.3217	0.3180
4	64	0.2436	0.2422

Table 015

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.8

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	0.7	0.8	0.6	0.9	0.8	0.8	1.0	0.6
MEAN								
8	0.9	1.0	0.7	1.2	1.0	1.0		
16	0.5	0.7	0.5	0.7	0.6	0.7		
LEADTIME								
2	0.6	0.9	0.6	0.9				
4	0.7	0.8	0.6	0.9				
C(FIX)/C(IN)								
32	0.5	0.7						
64	0.8	1.0						

LEADTIME	C(FIX)/C(IN)		
2	32	0.5	0.7
2	64	0.7	1.0
4	32	0.5	0.7
4	64	0.9	0.9

Table 016

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 1.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-4.3	3.5	2.3	0.1	1.3	1.0	0.2	1.8
MEAN								
8	-6.8	3.2	1.2	-0.6	-0.4	0.7		
16	-2.6	3.7	3.1	0.6	2.4	1.3		
LEADTIME								
2	-4.1	3.6	2.0	0.6				
4	-4.6	3.4	2.6	-0.4				
C(FIX)/C(IN)								
32	-2.3	4.3						
64	-6.0	2.8						

LEADTIME	C(FIX)/C(IN)		
2	32	-2.3	3.8
2	64	-5.5	3.4
4	32	-2.3	4.7
4	64	-6.5	2.3

Table 017

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPPOXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		2.3	-3.5	-4.8	4.1	0.7	-1.0	1.3	-1.4
MEAN									
8		6.8	-5.7	-3.5	5.8	4.8	-1.6		
16		-1.0	-1.8	-5.8	2.8	-2.4	-0.5		
LEADTIME									
2		2.5	-1.7	-2.4	3.6				
4		2.1	-5.0	-6.7	4.5				
C(FIX)/C(IN)									
32		-0.6	-10.2						
64		4.9	3.0						
LEADTIME	C(FIX)/C(IN)								
2	32	0.4	-5.9						
2	64	4.4	2.4						
4	32	-1.3	-13.8						
4	64	5.4	3.4						

Table 018

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.4	-4.7	-0.2	1.1	-0.1	1.2	2.4	-0.7
MEAN								
8	7.8	-2.5	2.2	2.5	1.8	3.1		
16	5.4	-6.3	-1.9	0.0	-1.4	-0.1		
LEADTIME								
2	5.3	-5.0	-0.8	0.4				
4	7.6	-4.5	0.3	1.8				
C(FIX)/C(IN)								
32	5.5	-5.5						
64	7.0	-4.3						

LEADTIME	C(FIX)/C(IN)		
2	32	4.3	-5.4
2	64	5.9	-4.7
4	32	6.8	-5.5
4	64	8.0	-3.8

Table 019

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 2.3

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	2.7	-4.9	0.0	4.6	2.6	2.0	5.5	-0.8
MEAN								
8	6.1	-6.2	3.7	7.3	7.4	3.6		
16	-0.7	-3.5	-3.6	2.0	-2.0	0.4		
LEADTIME								
2	2.9	-3.1	0.9	4.4				
4	2.4	-6.6	-0.8	4.8				
C(FIX)/C(IN)								
32	0.5	-10.4						
64	4.8	0.7						

LEADTIME	C(FIX)/C(IN)		
2	32	1.3	-6.6
2	64	4.5	0.4
4	32	-0.2	-14.1
4	64	5.0	0.9

Table 020

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	2.3	-3.5	-4.8	4.1	0.7	-1.0	1.3	-1.4
MEAN								
8	6.8	-5.7	-3.5	5.8	4.8	-1.6		
16	-1.0	-1.8	-5.8	2.8	-2.4	-0.5		
LEADTIME								
2	2.5	-1.7	-2.4	3.6				
4	2.1	-5.0	-6.7	4.5				
C(FIX)/C(IN)								
32	-0.6	-10.2						
64	4.9	3.0						

LEADTIME	C(FIX)/C(IN)		
2	32	0.4	-5.9
2	64	4.4	2.4
4	32	-1.3	-13.8
4	64	5.4	3.4

Table 021

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		6.1	-4.9	-0.2	1.1	-0.3	0.9	2.4	-1.1
MEAN									
8		7.8	-2.6	2.2	2.5	1.7	3.0		
16		4.9	-6.5	-1.9	0.0	-1.7	-0.4		
LEADTIME									
2		5.0	-5.1	-0.8	0.4				
4		7.3	-4.8	0.3	1.8				
C(FIX)/C(IN)									
32		5.5	-5.5						
64		7.0	-4.3						
LEADTIME	C(FIX)/C(IN)								
2	32	4.3	-5.4						
2	64	5.9	-4.7						
4	32	6.8	-5.5						
4	64	8.0	-3.8						

Appendix P

Multi-item Data for the (24,24) Statistical Power Approximation

Model II

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information from a 24-Period Demand History, with Revision Every 24 Periods, Using Regression Estimates of Demand Means and Variances.

		page
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P16	Sources of Aggregate Period-End Inventory (% Excess Over DP)	P9
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Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices K and L.

Table P1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 811.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		37.4	62.6	45.6	54.4	46.6	53.4	42.1	57.9
MEAN									
8		15.6	26.5	19.2	22.9	19.6	22.5		
16		21.8	36.1	26.4	31.5	27.0	30.9		
LEADTIME									
2		17.7	28.9	21.1	25.5				
4		19.7	33.7	24.5	28.9				
C(FIX)/C(IN)									
32		16.6	29.0						
64		20.8	33.6						
LEADTIME	C(FIX)/C(IN)								
2	32	7.8	13.3						
2	64	9.9	15.6						
4	32	8.8	15.7						
4	64	10.9	18.0						

Table P3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 469.0 PERCENT OF TOTAL COST= 57.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.9	71.1	47.7	52.3	45.8	54.2	42.1	57.9
MEAN									
	8	11.9	30.2	20.1	22.0	19.3	22.8		
	16	17.0	40.9	27.6	30.3	26.6	31.3		
LEADTIME									
	2	13.3	32.5	21.6	24.2				
	4	15.6	38.6	26.1	28.1				
C(FIX)/C(IN)									
	32	13.5	34.2						
	64	15.4	36.9						

LEADTIME	C(FIX)/C(IN)		
2	32	6.1	15.5
2	64	7.2	17.0
4	32	7.4	18.7
4	64	8.2	19.9

Table P4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 133.0 PERCENT OF TOTAL COST= 16.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		46.9	53.1	47.4	52.6	43.1	56.9	43.0	57.0
MEAN									
	8	20.2	22.8	20.1	22.9	18.7	24.3		
	16	26.7	30.3	27.2	29.8	24.4	32.6		
LEADTIME									
	2	20.8	22.2	20.6	22.4				
	4	26.1	30.9	26.7	30.2				
C(FIX)/C(IN)									
	32	21.9	25.4						
	64	25.0	27.7						

LEADTIME	C(FIX)/C(IN)		
2	32	9.7	10.9
2	64	11.1	11.3
4	32	12.2	14.5
4	64	13.8	16.4

Table P5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 209.2 PERCENT OF TOTAL COST= 25.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.3	49.7	39.8	60.2	50.6	49.4	41.5	58.5
MEAN									
	8	20.9	20.6	16.6	24.9	21.0	20.5		
	16	29.4	29.1	23.2	35.3	29.7	28.8		
LEADTIME									
	2	25.5	25.1	20.2	30.4				
	4	24.8	24.6	19.6	29.8				
C(FIX)/C(IN)									
	32	20.1	19.7						
	64	30.2	30.0						

LEADTIME	C(FIX)/C(IN)		
2	32	10.2	10.0
2	64	15.3	15.1
4	32	9.9	9.7
4	64	14.9	14.8

Table P6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1020

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.1916	0.0125	0.0994	0.1047	0.1003	0.1037	0.1029	0.1012
	8	0.1935	0.0124	0.0997	0.1061	0.1017	0.1041		
	16	0.1897	0.0127	0.0991	0.1032	0.0990	0.1034		
LEADTIME									
	2	0.1890	0.0117	0.0978	0.1029				
	4	0.1941	0.0133	0.1011	0.1064				
C(FIX)/C(IN)									
	32	0.1867	0.0121						
	64	0.1964	0.0129						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1840	0.0116
2	64	0.1940	0.0118
4	32	0.1894	0.0127
4	64	0.1989	0.0140

Table P7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0134

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.1625	0.0074	0.0127	0.0142	0.0116	0.0153	0.0174	0.0115
	8	0.2099	0.0096	0.0163	0.0185	0.0151	0.0196		
	16	0.1388	0.0064	0.0110	0.0120	0.0098	0.0132		
LEADTIME									
	2	0.1443	0.0062	0.0111	0.0121				
	4	0.1806	0.0086	0.0144	0.0162				
C(FIX)/C(IN)									
	32	0.1520	0.0071						
	64	0.1730	0.0077						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1343	0.0061
2	64	0.1543	0.0063
4	32	0.1696	0.0081
4	64	0.1917	0.0092

Table P8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2856

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2875	0.2837	0.3252	0.2460	0.2894	0.2818	0.2375	0.3337
MEAN									
	8	0.2391	0.2359	0.2716	0.2034	0.2402	0.2348		
	16	0.3359	0.3315	0.3787	0.2886	0.3386	0.3287		
LEADTIME									
	2	0.2916	0.2872	0.3300	0.2487				
	4	0.2834	0.2801	0.3203	0.2432				
C(FIX)/C(IN)									
	32	0.3281	0.3223						
	64	0.2469	0.2450						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3331	0.3270
2	64	0.2500	0.2475
4	32	0.3230	0.3176
4	64	0.2439	0.2426

Table P15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 7.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		4.3	10.2	8.7	7.2	6.3	9.3	8.6	7.4
MEAN									
8		4.7	11.0	9.3	8.0	6.8	10.2		
16		4.0	9.6	8.3	6.6	5.9	8.7		
LEADTIME									
2		3.1	8.3	7.2	5.5				
4		5.4	11.8	10.1	8.7				
C(FIX)/C(IN)									
32		4.8	11.1						
64		3.9	9.3						
LEADTIME	C(FIX)/C(IN)								
2	32	3.5	9.5						
2	64	2.8	7.3						
4	32	6.0	12.6						
4	64	4.9	11.1						

Table P16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 7.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	3.0	9.0	9.1	5.5	6.7	7.6	7.1	7.2
MEAN								
8	2.0	9.3	9.4	5.2	6.2	7.9		
16	3.8	8.7	8.9	5.7	7.1	7.3		
LEADTIME								
2	2.2	8.7	8.5	5.2				
4	3.8	9.2	9.7	5.7				
C(FIX)/C(IN)								
32	6.2	10.3						
64	0.4	7.7						

LEADTIME	C(FIX)/C(IN)		
2	32	5.0	9.9
2	64	-0.1	7.7
4	32	7.3	10.6
4	64	0.8	7.8

Table P17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 25.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	3.2	53.6	21.5	28.2	18.1	30.7	25.6	24.5
MEAN								
8	5.4	51.3	20.1	30.9	19.8	30.4		
16	1.5	55.4	22.6	26.2	16.7	30.9		
LEADTIME								
2	0.5	41.1	16.5	19.5				
4	5.4	64.1	25.8	35.5				
C(FIX)/C(IN)								
32	0.3	48.6						
64	5.8	58.5						

LEADTIME	C(FIX)/C(IN)		
2	32	-1.6	39.1
2	64	2.5	43.1
4	32	1.9	56.7
4	64	8.6	71.3

Table P18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.7	-4.8	-0.2	1.2	0.0	1.3	2.5	-0.6
MEAN								
8	8.1	-2.5	2.0	2.9	1.7	3.4		
16	5.7	-6.3	-1.6	0.0	-1.1	-0.1		
LEADTIME								
2	5.6	-5.1	-0.7	0.5				
4	7.8	-4.4	0.5	1.9				
C(FIX)/C(IN)								
32	5.9	-5.6						
64	7.2	-4.2						

LEADTIME	C(FIX)/C(IN)		
2	32	4.6	-5.7
2	64	6.2	-4.7
4	32	7.3	-5.6
4	64	8.1	-3.6

Table P19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 1.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-0.1	35.7	-1.1	4.1	0.1	2.9	3.1	0.0
MEAN								
8	1.5	35.7	-0.2	6.3	2.3	3.8		
16	-1.7	35.7	-1.9	1.9	-2.0	2.0		
LEADTIME								
2	-1.2	27.6	-2.0	2.2				
4	0.9	43.6	-0.2	6.0				
C(FIX)/C(IN)								
32	-2.6	31.7						
64	2.4	39.7						

LEADTIME	C(FIX)/C(IN)		
2	32	-3.3	25.8
2	64	0.9	29.5
4	32	-2.0	37.6
4	64	3.9	49.5

Table P20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 25.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		3.2	53.6	21.5	28.2	18.1	30.7	25.6	24.5
MEAN									
8		5.4	51.3	20.1	30.9	19.8	30.4		
16		1.5	55.4	22.6	26.2	16.7	30.9		
LEADTIME									
2		0.5	41.1	16.5	19.5				
4		5.4	64.1	25.8	35.5				
C(FIX)/C(IN)									
32		0.3	48.6						
64		5.8	58.5						
LEADTIME	C(FIX)/C(IN)								
2	32	-1.6	39.1						
2	64	2.5	43.1						
4	32	1.9	56.7						
4	64	8.6	71.3						

Table P21

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.4

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.4	-5.0	-0.2	1.2	-0.2	1.1	2.4	-0.9
MEAN								
8	8.1	-2.8	2.0	2.9	1.4	3.4		
16	5.3	-6.5	-1.6	0.0	-1.3	-0.5		
LEADTIME								
2	5.3	-5.2	-0.7	0.5				
4	7.6	-4.8	0.5	1.9				
C(FIX)/C(IN)								
32	5.9	-5.6						
64	7.2	-4.2						

LEADTIME	C(FIX)/C(IN)		
2	32	4.6	-5.7
2	64	6.2	-4.7
4	32	7.3	-5.6
4	64	8.1	-3.6

Appendix Q

Multi-item Forecasts for the (24,24) Statistical Power Approximation

Model II

Forecasting Properties of Inventory System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information, Revision Taking Place Every 24 Periods Using a 24-Period Demand History and Regression Estimates of Demand Means and Variances. Forecasts Made at Each Revision Using a 24-Period Demand History.

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Note: The corresponding appendices in MacCormick (1974), are his Appendices T and U.

Table Q1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 737.8

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	39.2	60.8	45.1	54.9	47.9	52.1	41.8	58.2
MEAN								
8	16.3	25.5	19.0	22.9	20.1	21.8		
16	22.9	35.3	26.1	32.1	27.8	30.4		
LEADTIME								
2	19.0	28.9	21.4	26.5				
4	20.2	31.9	23.7	28.4				
C(FIX)/C(IN)								
32	17.2	27.9						
64	22.0	32.9						

LEADTIME	C(FIX)/C(IN)		
2	32	8.3	13.1
2	64	10.7	15.8
4	32	8.9	14.8
4	64	11.3	17.1

Table Q2

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 452.3 PERCENT OF TOTAL COST= 61.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.1	71.9	47.5	52.5	46.5	53.5	42.0	58.0
MEAN									
	8	11.5	30.4	20.0	22.0	19.5	22.4		
	16	16.6	41.4	27.5	30.5	26.9	31.1		
LEADTIME									
	2	13.3	33.2	21.8	24.6				
	4	14.9	38.7	25.7	27.9				
C(FIX)/C(IN)									
	32	13.0	34.5						
	64	15.1	37.4						

LEADTIME	C(FIX)/C(IN)		
2	32	6.1	15.8
2	64	7.2	17.4
4	32	7.0	18.7
4	64	7.9	20.0

Table Q3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 76.2 PERCENT OF TOTAL COST= 10.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		74.3	25.7	45.0	55.0	48.4	51.6	41.7	58.3
MEAN									
	8	32.1	9.6	19.3	22.5	20.6	21.2		
	16	42.2	16.1	25.7	32.6	27.8	30.4		
LEADTIME									
	2	34.8	13.7	21.6	26.8				
	4	39.5	12.0	23.4	28.2				
C(FIX)/C(IN)									
	32	34.2	10.8						
	64	40.1	14.9						

LEADTIME	C(FIX)/C(IN)		
2	32	16.1	5.5
2	64	18.6	8.2
4	32	18.0	5.3
4	64	21.5	6.7

Table Q4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 209.3 PERCENT OF TOTAL COST= 28.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.3	49.7	39.8	60.2	50.7	49.3	41.6	58.4
MEAN									
8		20.9	20.7	16.7	24.9	21.0	20.6		
16		29.4	29.1	23.2	35.2	29.7	28.8		
LEADTIME									
2		25.5	25.2	20.2	30.4				
4		24.8	24.6	19.6	29.7				
C(FIX)/C(IN)									
32		20.1	19.8						
64		30.2	29.9						
LEADTIME	C(FIX)/C(IN)								
2	32	10.2	10.1						
2	64	15.3	15.1						
4	32	9.9	9.7						
4	64	14.9	14.8						

Table Q5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.0974

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
	MEAN	0.1896	0.0053	0.0945	0.1003	0.0979	0.0969	0.0983	0.0965
	8	0.1920	0.0046	0.0957	0.1009	0.0982	0.0984		
	16	0.1871	0.0059	0.0933	0.0997	0.0977	0.0954		
	LEADTIME								
	2	0.1900	0.0058	0.0954	0.1005				
	4	0.1891	0.0047	0.0937	0.1001				
	C(FIX)/C(IN)								
	32	0.1847	0.0044						
	64	0.1945	0.0061						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1858	0.0049						
2	64	0.1943	0.0068						
4	32	0.1835	0.0039						
4	64	0.1947	0.0055						

Table Q6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0077

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
	MEAN	0.1475	0.0021	0.0069	0.0085	0.0075	0.0080	0.0097	0.0067
	8	0.1914	0.0023	0.0089	0.0104	0.0095	0.0098		
	16	0.1255	0.0019	0.0059	0.0075	0.0064	0.0070		
	LEADTIME								
	2	0.1380	0.0022	0.0067	0.0083				
	4	0.1569	0.0019	0.0072	0.0087				
	C(FIX)/C(IN)								
	32	0.1356	0.0017						
	64	0.1593	0.0024						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1281	0.0018						
2	64	0.1479	0.0026						
4	32	0.1431	0.0017						
4	64	0.1708	0.0022						

Table Q7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2858

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2875	0.2841	0.3256	0.2460	0.2899	0.2816	0.2380	0.3335
MEAN									
	8	0.2394	0.2367	0.2723	0.2037	0.2410	0.2350		
	16	0.3357	0.3314	0.3789	0.2882	0.3388	0.3282		
LEADTIME									
	2	0.2920	0.2879	0.3310	0.2489				
	4	0.2831	0.2802	0.3203	0.2430				
C(FIX)/C(IN)									
	32	0.3280	0.3233						
	64	0.2471	0.2448						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3332	0.3287
2	64	0.2507	0.2471
4	32	0.3227	0.3178
4	64	0.2434	0.2426

Table Q8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF VARIANCE OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 1432.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		13.6	86.4	47.6	52.4	38.2	61.8	33.5	66.5
MEAN									
8		5.5	28.0	15.9	17.6	15.7	17.8		
16		8.0	58.4	31.7	34.7	22.5	43.9		
LEADTIME									
2		4.6	33.7	16.6	21.6				
4		9.0	52.7	31.0	30.7				
C(FIX)/C(IN)									
32		6.5	41.1						
64		7.1	45.3						
LEADTIME	C(FIX)/C(IN)								
2	32	2.1	14.5						
2	64	2.4	19.2						
4	32	4.4	26.6						
4	64	4.6	26.1						

Table Q9

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 37.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		13.9	35.2	26.1	27.4	23.4	29.7	21.9	30.9
MEAN									
8		8.9	20.0	15.1	15.9	15.0	16.0		
16		10.7	28.9	21.3	22.3	18.0	25.1		
LEADTIME									
2		8.1	22.0	15.4	17.6				
4		11.4	27.5	21.1	21.0				
C(FIX)/C(IN)									
32		9.7	24.3						
64		10.1	25.5						
LEADTIME	C(FIX)/C(IN)								
2	32	5.5	14.4						
2	64	5.9	16.6						
4	32	7.9	19.5						
4	64	8.1	19.3						

Table Q10

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 21.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		7.2	19.8	15.2	14.7	13.1	16.6	13.5	16.2
MEAN									
8		4.6	12.7	9.6	9.5	8.4	10.6		
16		5.5	15.3	11.8	11.2	10.0	12.8		
LEADTIME									
2		4.2	12.4	9.4	9.1				
4		5.9	15.5	11.9	11.5				
C(FIX)/C(IN)									
32		5.0	14.3						
64		5.2	13.7						
LEADTIME	C(FIX)/C(IN)								
2	32	2.9	8.9						
2	64	3.0	8.6						
4	32	4.1	11.2						
4	64	4.3	10.7						

Table Q11

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 29.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		10.5	28.0	20.4	21.9	18.9	23.1	16.0	25.3
MEAN									
8		6.5	14.6	10.8	11.8	11.9	10.6		
16		8.3	23.9	17.3	18.4	14.7	20.5		
LEADTIME									
2		6.2	17.9	12.3	14.4				
4		8.5	21.5	16.3	16.5				
C(FIX)/C(IN)									
32		7.1	19.1						
64		7.8	20.4						
LEADTIME	C(FIX)/C(IN)								
2	32	4.0	11.6						
2	64	4.8	13.6						
4	32	5.9	15.1						
4	64	6.1	15.3						

Table Q12

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 5.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		3.8	3.8	2.9	4.5	3.9	3.7	3.7	3.9
MEAN									
8		2.6	2.6	2.0	3.2	2.6	2.7		
16		2.8	2.7	2.2	3.2	2.9	2.6		
LEADTIME									
2		2.7	2.7	2.1	3.2				
4		2.7	2.6	2.0	3.2				
C(FIX)/C(IN)									
32		2.1	2.1						
64		3.2	3.2						
LEADTIME	C(FIX)/C(IN)								
2	32	1.5	1.5						
2	64	2.3	2.3						
4	32	1.4	1.4						
4	64	2.3	2.2						

Table Q13

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

S.D. OF BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1729

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1679	0.0413	0.1194	0.1251	0.1189	0.1256	0.1279	0.1164
MEAN									
	8	0.1249	0.0276	0.0862	0.0946	0.0890	0.0919		
	16	0.1122	0.0307	0.0827	0.0819	0.0789	0.0856		
LEADTIME									
	2	0.1151	0.0300	0.0817	0.0864				
	4	0.1223	0.0285	0.0871	0.0904				
C(FIX)/C(IN)									
	32	0.1162	0.0275						
	64	0.1212	0.0309						

LEADTIME	C(FIX)/C(IN)		
2	32	0.0792	0.0199
2	64	0.0835	0.0224
4	32	0.0850	0.0190
4	64	0.0879	0.0212

Table Q14

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 9.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	4.6	11.7	10.1	8.1	6.6	11.2	9.6	8.6
MEAN								
8	4.7	12.5	10.3	9.0	6.9	12.0		
16	4.5	11.1	10.0	7.5	6.4	10.6		
LEADTIME								
2	2.5	9.1	7.9	5.5				
4	6.5	13.9	12.0	10.5				
C(FIX)/C(IN)								
32	5.6	12.7						
64	3.8	10.8						

LEADTIME	C(FIX)/C(IN)		
2	32	3.1	10.7
2	64	2.0	7.7
4	32	7.9	14.3
4	64	5.4	13.5

Table Q15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 3.6

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.1	2.5	3.9	3.2	2.2	4.7	3.9	3.3
MEAN								
8	6.6	2.8	4.4	3.4	2.2	5.3		
16	5.7	2.4	3.6	3.1	2.2	4.3		
LEADTIME								
2	3.9	1.5	2.7	1.8				
4	7.9	3.4	5.0	4.4				
C(FIX)/C(IN)								
32	7.0	2.7						
64	5.3	2.4						

LEADTIME	C(FIX)/C(IN)		
2	32	4.7	1.9
2	64	3.3	1.2
4	32	8.9	3.5
4	64	7.0	3.4

Table Q16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 42.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	9.2	72.2	45.6	40.1	35.6	48.1	44.4	41.4
MEAN								
8	8.8	75.9	45.2	43.6	36.8	50.1		
16	9.6	69.5	45.9	37.3	34.6	46.5		
LEADTIME								
2	4.4	64.8	40.0	31.5				
4	13.1	77.6	49.9	46.4				
C(FIX)/C(IN)								
32	10.8	75.7						
64	7.9	69.1						

LEADTIME	C(FIX)/C(IN)		
2	32	4.7	71.4
2	64	4.2	58.4
4	32	15.6	78.9
4	64	10.9	76.5

Table Q17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= -0.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-0.0	-0.1	-0.1	0.0	-0.2	0.1	-0.2	0.1

MEAN						
8	-0.2	-0.2	-0.3	-0.2	-0.3	-0.2
16	0.1	0.1	-0.0	0.1	-0.1	0.2

LEADTIME						
2	-0.2	-0.1	-0.3	-0.1		
4	0.1	-0.0	0.0	0.1		

C(FIX)/C(IN)						
32	0.0	-0.3				
64	-0.1	0.1				

LEADTIME	C(FIX)/C(IN)					
2	32	-0.0	-0.5			
2	64	-0.3	0.2			
4	32	0.1	-0.1			
4	64	0.2	0.0			

Table Q18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 4.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	1.0	58.0	4.9	4.2	2.4	6.6	4.5	4.6
MEAN								
8	0.7	62.9	4.0	4.9	3.5	5.4		
16	1.3	53.2	5.8	3.4	1.3	7.7		
LEADTIME								
2	-0.5	50.0	2.5	2.3				
4	2.6	64.9	7.3	5.9				
C(FIX)/C(IN)								
32	1.1	64.0						
64	1.0	52.3						

LEADTIME	C(FIX)/C(IN)		
2	32	-1.0	57.7
2	64	-0.1	42.5
4	32	3.1	69.7
4	64	2.1	60.5

Table Q19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 42.7

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	9.2	72.2	45.6	40.1	35.6	48.1	44.4	41.4
MEAN								
8	8.8	75.9	45.2	43.6	36.8	50.1		
16	9.6	69.5	45.9	37.3	34.6	46.5		
LEADTIME								
2	4.4	64.8	40.0	31.5				
4	13.1	77.6	49.9	46.4				
C(FIX)/C(IN)								
32	10.8	75.7						
64	7.9	69.1						

LEADTIME	C(FIX)/C(IN)		
2	32	4.7	71.4
2	64	4.2	58.4
4	32	15.6	78.9
4	64	10.9	76.5

Table Q20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL II

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= -0.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-0.0	-0.1	-0.1	0.0	-0.2	0.0	-0.2	0.0

MEAN						
8	-0.1	-0.4	-0.3	-0.2	-0.4	-0.1
16	0.1	0.0	-0.0	0.1	-0.1	0.1

LEADTIME						
2	-0.1	-0.2	-0.3	-0.1		
4	0.1	-0.0	0.0	0.1		

C(FIX)/C(IN)		
32	0.0	-0.3
64	-0.1	0.1

LEADTIME	C(FIX)/C(IN)		
2	32	-0.0	-0.5
2	64	-0.3	0.2
4	32	0.1	-0.1
4	64	0.2	0.0

Appendix R

Multi-item Data for the Power Approximation

Model III

System of 16 Items with Negative Binomial Demand Distributions

(Variance/Mean = 3) Controlled Optimally with Full Information.

		page
Table R1	Sources of Expected Total Cost	R1
R3	Sources of Aggregate Period-End Inventory	R2
R4	Sources of Aggregate Backlog Cost	R3
R5	Sources of Aggregate Replenishment Cost	R4
R6	Backlog Frequency	R5
R7	Weighted Proportion of Demand Backlogged	R6
R8	Replenishment Frequency	R7

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendix C.

Table R1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, OPTIMAL CONTROL (DP)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 718.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.7	61.3	45.5	54.5	47.2	52.8	42.1	57.9
MEAN									
8		16.1	25.9	19.2	22.9	19.9	22.2		
16		22.6	35.3	26.3	31.6	27.3	30.6		
LEADTIME									
2		18.5	28.7	21.3	25.9				
4		20.2	32.6	24.2	28.6				
C(FIX)/C(IN)									
32		17.2	28.3						
64		21.5	33.0						
LEADTIME	C(FIX)/C(IN)								
2	32	8.1	13.2						
2	64	10.4	15.5						
4	32	9.1	15.2						
4	64	11.2	17.4						

Table R3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, OPTIMAL CONTROL (DP)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 428.9 PERCENT OF TOTAL COST= 59.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		30.4	69.6	46.6	53.4	45.5	54.5	42.5	57.5
MEAN									
8		12.7	29.8	19.8	22.7	19.4	23.1		
16		17.7	39.8	26.8	30.7	26.1	31.4		
LEADTIME									
2		14.0	31.5	21.0	24.5				
4		16.4	38.1	25.6	29.0				
C(FIX)/C(IN)									
32		13.8	32.8						
64		16.6	36.8						
LEADTIME	C(FIX)/C(IN)								
2	32	6.3	14.7						
2	64	7.7	16.7						
4	32	7.5	10.0						
4	64	8.9	20.1						

Table R4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, OPTIMAL CONTROL (DP)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 101.6 PERCENT OF TOTAL COST= 14.1

		C(OUT)/C(IN)		C(PIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		56.5	43.5	49.2	50.8	45.1	54.9	43.5	56.5
MEAN									
	8	24.1	19.3	21.3	22.2	19.6	23.8		
	16	32.3	24.2	27.9	28.7	25.5	31.1		
LEADTIME									
	2	25.4	19.7	22.1	23.0				
	4	31.1	23.8	27.0	27.8				
C(PIX)/C(IN)									
	32	27.3	21.9						
	64	29.2	21.7						

LEADTIME	C(PIX)/C(IN)		
2	32	12.2	9.9
2	64	13.2	9.8
4	32	15.1	11.9
4	64	16.0	11.9

Table R5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 187.7 PERCENT OF TOTAL COST= 26.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		48.2	51.8	41.2	58.8	52.2	47.8	40.3	59.7
MEAN									
	8	19.6	20.7	16.7	23.6	21.1	19.2		
	16	28.6	31.1	24.5	35.2	31.1	28.6		
LEADTIME									
	2	25.1	27.1	21.5	30.7				
	4	23.1	24.7	19.7	28.1				
C(FIX)/C(IN)									
	32	19.6	21.6						
	64	28.6	30.3						
LEADTIME	C(FIX)/C(IN)								
2	32	10.3	11.2						
2	64	14.8	15.9						
4	32	9.3	10.3						
4	64	13.8	14.4						

Table R6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, OPTIMAL CONTROL(DP)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1002

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1913	0.0092	0.0999	0.1006	0.0996	0.1009	0.0994	0.1011
MEAN									
	8	0.1896	0.0091	0.0990	0.0998	0.0983	0.1004		
	16	0.1929	0.0093	0.1008	0.1014	0.1008	0.1014		
LEADTIME									
	2	0.1900	0.0091	0.0991	0.1000				
	4	0.1926	0.0093	0.1007	0.1011				
C(FIX)/C(IN)									
	32	0.1905	0.0093						
	64	0.1921	0.0091						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1890	0.0092
2	64	0.1911	0.0090
4	32	0.1921	0.0094
4	64	0.1930	0.0092

Table R7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, OPTIMAL CONTROL(DP)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0103

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
	MEAN	0.1493	0.0047	0.0101	0.0104	0.0093	0.0113	0.0134	0.0087
	8	0.1913	0.0062	0.0131	0.0137	0.0121	0.0147		
	16	0.1283	0.0039	0.0086	0.0088	0.0078	0.0096		
	LEADTIME								
	2	0.1343	0.0042	0.0091	0.0094				
	4	0.1643	0.0051	0.0111	0.0114				
	C(FIX)/C(IN)								
	32	0.1443	0.0047						
	64	0.1543	0.0046						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1290	0.0042						
2	64	0.1396	0.0042						
4	32	0.1597	0.0051						
4	64	0.1690	0.0051						

Table R8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, OPTIMAL CONTROL (DP)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2587

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2483	0.2692	0.3018	0.2157	0.2702	0.2473	0.2088	0.3087
MEAN									
	8	0.2037	0.2140	0.2446	0.1731	0.2188	0.1988		
	16	0.2929	0.3244	0.3591	0.2582	0.3215	0.2958		
LEADTIME									
	2	0.2592	0.2811	0.3153	0.2250				
	4	0.2374	0.2572	0.2883	0.2063				
C(FIX)/C(IN)									
	32	0.2872	0.3164						
	64	0.2094	0.2219						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3011	0.3295
2	64	0.2172	0.2327
4	32	0.2732	0.3034
4	64	0.2016	0.2110

Appendix S

Multi-item Data for the Power Approximation

Model III

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled Approximately Optimally with Full Information.

		page
Table S1	Sources of Expected Total Cost	S1
S3	Sources of Aggregate Period-End Inventory	S2
S4	Sources of Aggregate Backlog Cost	S3
S5	Sources of Aggregate Replenishment Cost	S4
S6	Backlog Frequency	S5
S7	Weighted Proportion of Demand Backlogged	S6
S8	Replenishment Frequency	S7
S15	Sources of Total Cost (% Excess Over DP)	S8
S16	Sources of Aggregate Period-End Inventory (% Excess Over DP)	S9
S17	Sources of Aggregate Backlog Cost (% Excess Over DP)	S10
S18	Sources of Aggregate Replenishment Cost (% Excess Over DP)	S11
S19	Backlog Frequency (% Excess Over DP)	S12
S20	Weighted Proportion of Demand Backlogged (% Excess Over DP)	S13
S21	Replenishment Frequency (% Excess Over DP)	S14

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices E and F.

Table S1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 760.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.1	61.9	45.6	54.4	47.1	52.9	42.0	58.0
MEAN									
8		15.9	26.1	19.1	22.9	19.9	22.1		
16		22.2	35.8	26.5	31.5	27.2	30.8		
LEADTIME									
2		18.2	28.9	21.3	25.8				
4		19.9	33.0	24.3	28.6				
C(FIX)/C(IN)									
32		17.0	28.6						
64		21.2	33.2						
LEADTIME	C(FIX)/C(IN)								
2	32	8.1	13.3						
2	64	10.1	15.7						
4	32	8.9	15.4						
4	64	11.0	17.6						

Table S3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 466.2 PERCENT OF TOTAL COST= 61.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.6	71.4	46.8	53.2	45.1	54.9	43.4	56.6
MEAN									
8		12.3	31.1	20.4	23.0	20.3	23.1		
16		16.3	40.3	26.4	30.3	24.7	31.9		
LEADTIME									
2		13.0	32.1	20.1	25.0				
4		15.6	39.4	26.7	28.3				
C(FIX)/C(IN)									
32		13.0	33.8						
64		15.6	37.6						
LEADTIME	C(FIX)/C(IN)								
2	32	5.6	14.5						
2	64	7.4	17.6						
4	32	7.4	19.3						
4	64	8.2	20.1						

Table S4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 94.9 PERCENT OF TOTAL COST= 12.5

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		58.5	41.5	46.3	53.7	47.7	52.3	39.6	60.4
MEAN									
8		24.0	15.6	19.3	20.3	17.9	21.8		
16		34.5	25.9	27.0	33.4	29.9	30.5		
LEADTIME									
2		27.2	20.5	23.7	24.0				
4		31.3	21.0	22.5	29.7				
C(FIX)/C(IN)									
32		27.4	18.9						
64		31.1	22.7						
LEADTIME	C(FIX)/C(IN)								
2	32	13.3	10.4						
2	64	13.9	10.2						
4	32	14.1	8.5						
4	64	17.2	12.5						

Table S5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 199.0 PERCENT OF TOTAL COST= 26.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	50.8	49.2	42.6	57.4	51.6	48.4	39.8	60.2
MEAN								
8	20.5	19.3	15.8	24.0	19.8	20.0		
16	30.3	29.9	26.7	33.4	31.8	28.3		
LEADTIME								
2	26.1	25.5	23.0	28.6				
4	24.7	23.7	19.5	28.8				
C(FIX)/C(IN)								
32	21.3	21.3						
64	29.5	28.0						

LEADTIME	C(FIX)/C(IN)		
2	32	11.3	11.7
2	64	14.8	13.8
4	32	10.0	9.6
4	64	14.7	14.1

Table S6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.0929

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1782	0.0076	0.0914	0.0944	0.0946	0.0912	0.0892	0.0966
MEAN									
	8	0.1718	0.0066	0.0887	0.0897	0.0880	0.0904		
	16	0.1846	0.0085	0.0941	0.0991	0.1011	0.0920		
LEADTIME									
	2	0.1811	0.0080	0.0960	0.0931				
	4	0.1753	0.0071	0.0868	0.0956				
C(FIX)/C(IN)									
	32	0.1756	0.0071						
	64	0.1808	0.0080						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1838	0.0082
2	64	0.1785	0.0078
4	32	0.1675	0.0060
4	64	0.1830	0.0082

Table S7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0096

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.1446	0.0041	0.0089	0.0103	0.0092	0.0100	0.0114	0.0087
	8	0.1781	0.0047	0.0111	0.0117	0.0103	0.0125		
	16	0.1279	0.0039	0.0078	0.0096	0.0086	0.0088		
LEADTIME									
	2	0.1345	0.0041	0.0091	0.0092				
	4	0.1547	0.0042	0.0087	0.0114				
C(FIX)/C(IN)									
	32	0.1355	0.0038						
	64	0.1537	0.0045						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1319	0.0042
2	64	0.1371	0.0041
4	32	0.1392	0.0034
4	64	0.1702	0.0050

Table S8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2770

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2801	0.2739	0.3308	0.2232	0.2901	0.2639	0.2163	0.3377
MEAN									
	8	0.2231	0.2096	0.2460	0.1867	0.2156	0.2171		
	16	0.3371	0.3382	0.4155	0.2598	0.3645	0.3108		
LEADTIME									
	2	0.2909	0.2893	0.3578	0.2224				
	4	0.2693	0.2586	0.3037	0.2241				
C(FIX)/C(IN)									
	32	0.3311	0.3304						
	64	0.2291	0.2174						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3522	0.3633
2	64	0.2295	0.2152
4	32	0.3100	0.2974
4	64	0.2286	0.2197

Table S15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 5.8

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	4.2	6.9	6.0	5.7	5.7	6.0	5.7	6.0
MEAN								
8	4.3	6.5	5.1	6.2	6.0	5.4		
16	4.1	7.2	6.7	5.4	5.5	6.4		
LEADTIME								
2	4.1	6.7	5.9	5.5				
4	4.2	7.1	6.1	5.9				
C(FIX)/C(IN)								
32	4.3	7.1						
64	4.1	6.8						

LEADTIME	C(FIX)/C(IN)		
2	32	4.7	6.6
2	64	3.6	6.8
4	32	3.9	7.4
4	64	4.5	6.7

Table S16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 8.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		2.1	11.6	9.1	8.3	7.7	9.5	11.0	7.0
MEAN									
	8	4.8	13.6	12.0	10.1	14.1	8.3		
	16	0.1	10.1	7.1	7.0	3.0	10.4		
LEADTIME									
	2	0.9	10.7	3.9	11.0				
	4	3.1	12.3	13.4	6.1				
C(FIX)/C(IN)									
	32	2.3	12.0						
	64	1.9	11.2						

LEADTIME	C(FIX)/C(IN)		
2	32	-3.0	6.9
2	64	4.1	14.2
4	32	6.6	16.2
4	64	0.1	8.7

Table S17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -6.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-3.2	-10.9	-12.0	-1.2	-1.1	-11.0	-14.7	-0.2
MEAN								
8	-6.9	-24.5	-15.2	-14.3	-15.0	-14.5		
16	-0.3	-0.0	-9.6	8.9	9.7	-8.3		
LEADTIME								
2	0.2	-2.7	0.2	-2.3				
4	-5.9	-17.7	-22.1	-0.3				
C(FIX)/C(IN)								
32	-6.1	-19.4						
64	-0.4	-2.3						

LEADTIME	C(FIX)/C(IN)		
2	32	2.3	-2.3
2	64	-1.8	-3.1
4	32	-12.9	-33.7
4	64	0.7	-1.6

Table S18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 6.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	11.8	0.7	9.6	3.5	4.9	7.3	4.9	6.8
MEAN								
8	11.0	-0.9	0.6	7.9	-0.5	10.7		
16	12.3	1.7	15.7	0.6	8.5	5.0		
LEADTIME								
2	10.3	-0.2	13.5	-1.2				
4	13.4	1.6	5.4	8.6				
C(FIX)/C(IN)								
32	15.3	4.4						
64	9.4	-2.0						

LEADTIME	C(FIX)/C(IN)		
2	32	17.0	10.3
2	64	5.7	-7.5
4	32	13.5	-2.0
4	64	13.4	4.1

Table S19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -7.3

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-6.8	-17.7	-8.5	-6.2	-5.0	-9.6	-10.2	-4.5
MEAN								
8	-9.4	-27.7	-10.4	-10.1	-10.5	-10.0		
16	-4.3	-7.9	-6.7	-2.3	0.3	-9.3		
LEADTIME								
2	-4.7	-11.9	-3.1	-6.9				
4	-9.0	-23.5	-13.8	-5.5				
C(FIX)/C(IN)								
32	-7.8	-23.0						
64	-5.9	-12.4						

LEADTIME	C(FIX)/C(IN)		
2	32	-2.8	-10.4
2	64	-6.6	-13.5
4	32	-12.8	-35.4
4	64	-5.2	-11.3

Table S20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -6.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-3.2	-10.9	-12.0	-1.2	-1.1	-11.0	-14.7	-0.2
MEAN								
8	-6.9	-24.5	-15.2	-14.3	-15.0	-14.5		
16	-0.3	-0.0	-9.6	8.9	9.7	-8.3		
LEADTIME								
2	0.2	-2.7	0.2	-2.3				
4	-5.9	-17.7	-22.1	-0.3				
C(FIX)/C(IN)								
32	-6.1	-19.4						
64	-0.4	-2.3						

LEADTIME	C(FIX)/C(IN)		
2	32	2.3	-2.3
2	64	-1.8	-3.1
4	32	-12.9	-33.7
4	64	0.7	-1.6

Table S21

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 7.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	12.8	1.8	9.6	3.5	7.4	6.7	3.6	9.4
MEAN								
8	9.5	-2.0	0.6	7.9	-1.4	9.2		
16	15.1	4.3	15.7	0.6	13.4	5.1		
LEADTIME								
2	12.2	2.9	13.5	-1.2				
4	13.4	0.5	5.4	8.6				
C(FIX)/C(IN)								
32	15.3	4.4						
64	9.4	-2.0						

LEADTIME	C(FIX)/C(IN)		
2	32	17.0	10.3
2	64	5.7	-7.5
4	32	13.5	-2.0
4	64	13.4	4.1

Appendix T

Multi-item Data for the (24,24) Statistical Power Approximation

Model III

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information from a 24-Period Demand History, with Revision Every 24 Periods, Using Regression Estimates of Demand Means and Variances.

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T5	Sources of Aggregate Replenishment Cost	T4
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T7	Weighted Proportion of Demand Backlogged	T6
T8	Replenishment Frequency	T7
T15	Sources of Total Cost (% Excess Over DP)	T8
T16	Sources of Aggregate Period-End Inventory (% Excess Over DP)	T9
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T18	Sources of Aggregate Replenishment Cost (% Excess Over DP)	T11
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Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices K and L.

Table T1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 824.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		36.7	63.3	45.8	54.2	46.5	53.5	42.4	57.6
MEAN									
	8	15.4	27.0	19.4	22.9	19.8	22.6		
	16	21.3	36.3	26.4	31.2	26.7	30.9		
LEADTIME									
	2	17.4	29.1	21.2	25.3				
	4	19.3	34.2	24.6	28.9				
C(FIX)/C(IN)									
	32	16.4	29.5						
	64	20.3	33.8						

LEADTIME	C(FIX)/C(IN)		
2	32	7.7	13.5
2	64	9.7	15.6
4	32	8.7	16.0
4	64	10.7	18.2

Table T3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 496.6 PERCENT OF TOTAL COST= 60.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.7	71.3	46.4	53.6	45.0	55.0	44.1	55.9
MEAN									
8		12.5	31.6	20.8	23.2	20.5	23.6		
16		16.2	39.7	25.6	30.3	24.5	31.4		
LEADTIME									
2		13.0	32.0	20.2	24.9				
4		15.7	39.3	26.2	28.7				
C(FIX)/C(IN)									
32		12.9	33.5						
64		15.8	37.8						
LEADTIME	C(FIX)/C(IN)								
2	32	5.6	14.6						
2	64	7.4	17.5						
4	32	7.3	18.9						
4	64	8.4	20.4						

Table T4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 128.5 PERCENT OF TOTAL COST= 15.6

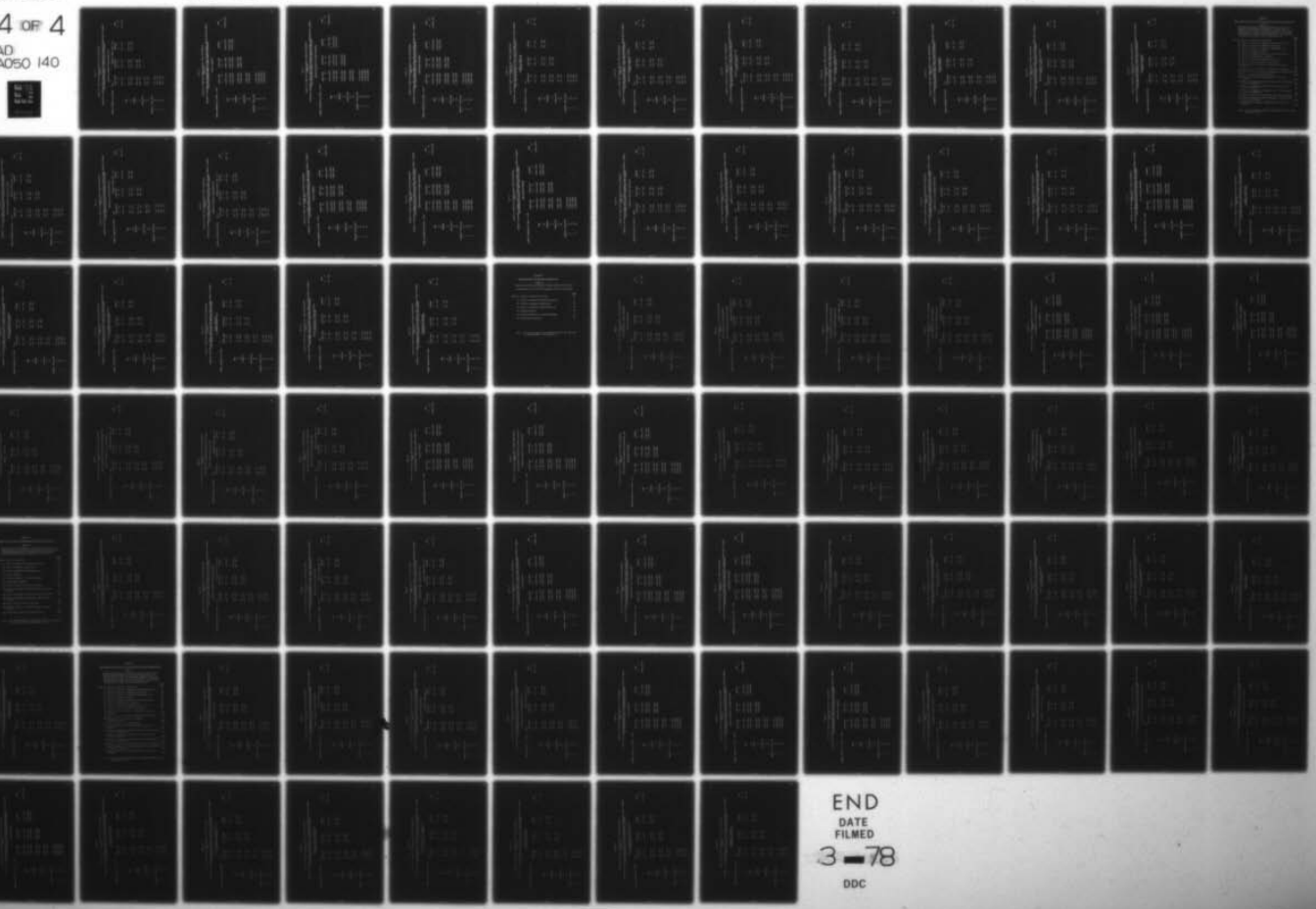
	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	45.6	54.4	48.4	51.6	44.7	55.3	40.0	60.0
MEAN								
8	18.9	21.1	19.9	20.1	17.0	23.0		
16	26.7	33.3	28.5	31.4	27.7	32.3		
LEADTIME								
2	20.7	24.0	22.7	22.0				
4	24.9	30.4	25.8	29.5				
C(FIX)/C(IN)								
32	21.9	26.6						
64	23.7	27.8						

LEADTIME	C(FIX)/C(IN)		
2	32	10.3	12.4
2	64	10.5	11.6
4	32	11.6	14.1
4	64	13.3	16.2

AD-A050 140 NORTH CAROLINA UNIV AT CHAPEL HILL GRADUATE SCHOOL OF--ETC F/G 15/5
(S,S) INVENTORY POLICIES IN A NONSTATIONARY DEMAND ENVIRONMENT.--ETC(U)
APR 77 R L KAUFMAN. DAAG29-76-G-0323

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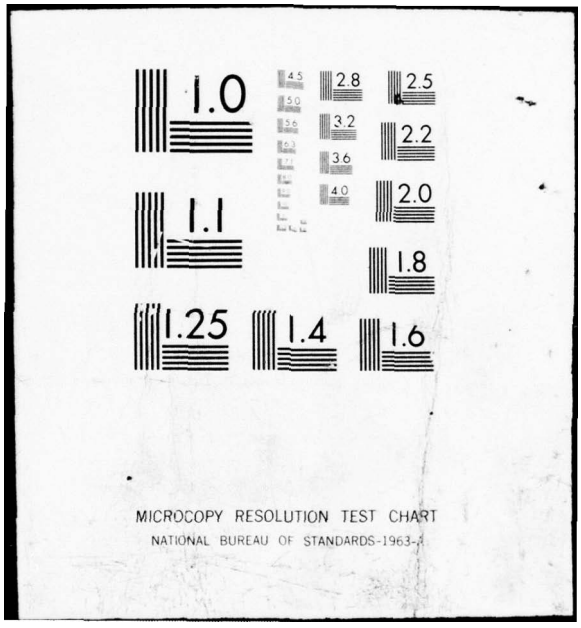

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Table T5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 199.3 PERCENT OF TOTAL COST= 24.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.8	49.2	42.7	57.3	51.3	48.7	39.7	60.3
MEAN									
8		20.5	19.2	15.7	24.0	19.7	19.9		
16		30.3	30.0	27.1	33.3	31.5	28.8		
LEADTIME									
2		26.0	25.3	22.7	28.5				
4		24.9	23.9	20.0	28.7				
C(FIX)/C(IN)									
32		21.4	21.4						
64		29.5	27.8						
LEADTIME	C(FIX)/C(IN)								
2	32	11.2	11.5						
2	64	14.8	13.8						
4	32	10.2	9.8						
4	64	14.7	14.0						

Table T6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.0952

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
	MEAN	0.1789	0.0115	0.0952	0.0952	0.0952	0.0952	0.0920	0.0984
	8	0.1736	0.0104	0.0912	0.0929	0.0890	0.0951		
	16	0.1841	0.0127	0.0991	0.0976	0.1014	0.0954		
	LEADTIME								
	2	0.1792	0.0112	0.0974	0.0929				
	4	0.1785	0.0119	0.0929	0.0975				
	C(FIX)/C(IN)								
	32	0.1788	0.0115						
	64	0.1789	0.0116						
LEADTIME	C(FIX)/C(IN)								
2	32	0.1832	0.0116						
2	64	0.1752	0.0107						
4	32	0.1745	0.0113						
4	64	0.1826	0.0125						

Table T7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0130

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.1526	0.0074	0.0126	0.0134	0.0116	0.0144	0.0156	0.0117
	8	0.1899	0.0086	0.0155	0.0157	0.0133	0.0179		
	16	0.1340	0.0067	0.0111	0.0123	0.0108	0.0126		
LEADTIME									
	2	0.1387	0.0065	0.0118	0.0115				
	4	0.1666	0.0082	0.0134	0.0153				
C(FIX)/C(IN)									
	32	0.1464	0.0072						
	64	0.1588	0.0075						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1374	0.0067
2	64	0.1399	0.0063
4	32	0.1554	0.0076
4	64	0.1778	0.0088

Table T8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2778

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2810	0.2747	0.3327	0.2229	0.2880	0.2676	0.2155	0.3401
MEAN									
	8	0.2225	0.2086	0.2442	0.1869	0.2149	0.2161		
	16	0.3395	0.3407	0.4213	0.2589	0.3611	0.3191		
LEADTIME									
	2	0.2893	0.2867	0.3540	0.2220				
	4	0.2727	0.2626	0.3115	0.2238				
C(FIX)/C(IN)									
	32	0.3327	0.3328						
	64	0.2293	0.2165						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3489	0.3592
2	64	0.2298	0.2143
4	32	0.3165	0.3065
4	64	0.2289	0.2187

Table T15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 14.8

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	8.8	18.6	15.6	14.1	13.1	16.3	15.7	14.1
MEAN								
8	9.8	19.4	16.3	15.2	14.5	16.8		
16	8.0	18.0	15.1	13.3	12.1	15.9		
LEADTIME								
2	7.6	16.7	14.2	12.2				
4	9.8	20.3	16.8	15.9				
C(FIX)/C(IN)								
32	9.2	19.5						
64	8.4	17.9						

LEADTIME	C(FIX)/C(IN)		
2	32	8.5	17.8
2	64	7.0	15.7
4	32	9.9	20.9
4	64	9.8	19.8

Table T16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 15.8

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		9.4	18.6	15.4	16.1	14.7	16.7	20.1	12.6
MEAN									
8		13.7	22.9	21.9	18.6	22.9	17.9		
16		6.2	15.4	10.6	14.3	8.6	15.9		
LEADTIME									
2		7.8	17.8	11.2	17.6				
4		10.7	19.3	18.8	14.9				
C(FIX)/C(IN)									
32		8.8	18.2						
64		9.9	19.0						
LEADTIME	C(FIX)/C(IN)								
2	32	4.2	14.3						
2	64	10.7	20.9						
4	32	12.6	21.4						
4	64	9.2	17.4						

Table T17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 26.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	2.2	58.0	24.6	28.3	25.4	27.4	16.5	34.2
MEAN								
8	-0.8	38.0	18.2	14.8	9.6	22.2		
16	4.4	74.0	29.5	38.8	37.6	31.4		
LEADTIME								
2	3.3	53.9	29.7	21.3				
4	1.4	61.4	20.5	34.2				
C(FIX)/C(IN)								
32	1.4	53.5						
64	2.9	62.5						

LEADTIME	C(FIX)/C(IN)		
2	32	6.6	58.1
2	64	0.2	49.6
4	32	-2.7	49.8
4	64	5.2	73.1

Table T18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 6.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	12.1	0.7	10.2	3.4	4.3	8.3	4.6	7.3

MEAN

8	11.0	-1.4	-0.2	8.0	-0.6	10.4
16	12.8	2.2	17.3	0.3	7.6	6.9

LEADTIME

2	9.9	-0.9	12.3	-1.3
4	14.4	2.6	8.0	8.5

C(FIX)/C(IN)

32	15.8	5.2		
64	9.5	-2.4		

LEADTIME	C(FIX)/C(IN)		
2	32	15.8	9.0
2	64	5.8	-7.9
4	32	15.8	1.0
4	64	13.5	3.7

Table T19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -5.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		-6.5	25.4	-4.7	-5.3	-4.4	-5.7	-7.4	-2.7
MEAN									
	8	-8.4	14.0	-7.9	-6.9	-9.5	-5.3		
	16	-4.6	36.5	-1.6	-3.8	0.6	-6.0		
LEADTIME									
	2	-5.7	22.8	-1.7	-7.1				
	4	-7.3	27.9	-7.8	-3.6				
C(FIX)/C(IN)									
	32	-6.1	23.9						
	64	-6.9	26.9						

LEADTIME	C(FIX)/C(IN)		
2	32	-3.1	26.6
2	64	-8.3	18.9
4	32	-9.2	21.1
4	64	-5.4	34.7

Table T20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 26.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	2.2	58.0	24.6	28.3	25.4	27.4	16.5	34.2
MEAN								
8	-0.8	38.0	18.2	14.8	9.6	22.2		
16	4.4	74.0	29.5	38.8	37.6	31.4		
LEADTIME								
2	3.3	53.9	29.7	21.3				
4	1.4	61.4	20.5	34.2				
C(FIX)/C(IN)								
32	1.4	53.5						
64	2.9	62.5						

LEADTIME	C(FIX)/C(IN)		
2	32	6.6	58.1
2	64	0.2	49.6
4	32	-2.7	49.8
4	64	5.2	73.1

Table T21

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 7.4

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	13.2	2.0	10.2	3.4	6.6	8.2	9.2	10.2
MEAN								
8	9.2	-2.5	-0.2	8.0	-1.8	8.7		
16	15.9	5.0	17.3	0.3	12.3	7.9		
LEADTIME								
2	11.6	2.0	12.3	-1.3				
4	14.8	2.1	8.0	8.5				
C(FIX)/C(IN)								
32	15.8	5.2						
64	9.5	-2.4						

LEADTIME	C(FIX)/C(IN)		
2	32	15.8	9.0
2	64	5.8	-7.9
4	32	15.8	1.0
4	64	13.5	3.7

Appendix U

Multi-item Forecasts for the (24,24) Statistical Power Approximation

Model III

Forecasting Properties of Inventory System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information, Revision Taking Place Every 24 Periods Using a 24-Period Demand History and Regression Estimates of Demand Means and Variances. Forecasts Made at Each Revision Using a 24-Period Demand History.

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Note: The corresponding appendices in MacCormick (1974), are his Appendices T and U.

Table U1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 735.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.4	61.6	45.5	54.5	47.7	52.3	42.3	57.7
MEAN									
8		16.1	26.3	19.2	23.1	20.3	22.0		
16		22.4	35.3	26.3	31.4	27.4	30.3		
LEADTIME									
2		18.6	29.1	21.5	26.2				
4		19.8	32.5	24.0	28.3				
C(FIX)/C(IN)									
32		17.0	28.5						
64		21.5	33.0						
LEADTIME	C(FIX)/C(IN)								
2	32	8.2	13.4						
2	64	10.5	15.7						
4	32	8.8	15.2						
4	64	11.0	17.3						

Table U2

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 475.0 PERCENT OF TOTAL COST= 64.6

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.0	72.0	46.5	53.5	46.1	53.9	43.8	56.2
MEAN									
8		12.1	31.6	20.7	23.1	20.9	22.9		
16		15.9	40.3	25.8	30.5	25.2	31.0		
LEADTIME									
2		13.2	32.9	20.7	25.4				
4		14.9	39.0	25.8	28.1				
C(FIX)/C(IN)									
32		12.6	33.9						
64		15.5	38.0						
LEADTIME	C(FIX)/C(IN)								
2	32	5.7	15.0						
2	64	7.5	17.9						
4	32	6.9	18.9						
4	64	8.0	20.1						

Table U3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 61.6 PERCENT OF TOTAL COST= 8.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		78.4	21.6	47.1	52.9	49.2	50.8	39.9	60.1
MEAN									
8		32.2	7.7	18.8	21.1	18.0	21.9		
16		46.1	13.9	28.3	31.8	31.2	28.9		
LEADTIME									
2		37.3	11.9	24.6	24.7				
4		41.1	9.7	22.5	28.2				
C(FIX)/C(IN)									
32		36.8	10.3						
64		41.6	11.3						
LEADTIME	C(FIX)/C(IN)								
2	32	17.9	6.7						
2	64	19.5	5.2						
4	32	19.0	3.6						
4	64	22.1	6.1						

Table U4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 198.8 PERCENT OF TOTAL COST= 27.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.9	49.1	42.6	57.4	51.0	49.0	39.6	60.4
MEAN									
8		20.5	19.1	15.7	23.9	19.5	20.1		
16		30.5	30.0	27.0	33.5	31.5	28.9		
LEADTIME									
2		25.9	25.1	22.6	28.4				
4		25.0	23.9	20.0	29.0				
C(FIX)/C(IN)									
32		21.4	21.2						
64		29.5	27.8						
LEADTIME	C(FIX)/C(IN)								
2	32	11.2	11.4						
2	64	14.7	13.7						
4	32	10.2	9.8						
4	64	14.8	14.1						

Table U5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.0875

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1714	0.0035	0.0860	0.0890	0.0892	0.0857	0.0846	0.0904
MEAN									
	8	0.1659	0.0032	0.0832	0.0859	0.0821	0.0870		
	16	0.1770	0.0037	0.0887	0.0920	0.0963	0.0844		
LEADTIME									
	2	0.1744	0.0040	0.0897	0.0887				
	4	0.1685	0.0030	0.0822	0.0892				
C(FIX)/C(IN)									
	32	0.1687	0.0032						
	64	0.1742	0.0037						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1751	0.0043
2	64	0.1736	0.0037
4	32	0.1623	0.0022
4	64	0.1747	0.0037

Table U6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0062

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1257	0.0014	0.0059	0.0066	0.0061	0.0063	0.0075	0.0056
MEAN									
	8	0.1551	0.0015	0.0070	0.0079	0.0067	0.0082		
	16	0.1110	0.0014	0.0053	0.0059	0.0058	0.0054		
LEADTIME									
	2	0.1197	0.0015	0.0061	0.0061				
	4	0.1317	0.0013	0.0056	0.0070				
C(FIX)/C(IN)									
	32	0.1181	0.0013						
	64	0.1332	0.0015						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1145	0.0017
2	64	0.1248	0.0013
4	32	0.1217	0.0009
4	64	0.1417	0.0016

Table U7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2769

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2808	0.2730	0.3310	0.2228	0.2861	0.2678	0.2145	0.3393
MEAN									
8		0.2220	0.2071	0.2434	0.1856	0.2119	0.2172		
16		0.3397	0.3389	0.4186	0.2599	0.3603	0.3183		
LEADTIME									
2		0.2884	0.2837	0.3515	0.2206				
4		0.2733	0.2622	0.3106	0.2249				
C(FIX)/C(IN)									
32		0.3322	0.3299						
64		0.2295	0.2161						
LEADTIME	C(FIX)/C(IN)								
2	32	0.3482	0.3548						
2	64	0.2285	0.2127						
4	32	0.3161	0.3050						
4	64	0.2304	0.2195						

Table U8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF VARIANCE OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 1489.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		13.2	86.8	45.7	54.3	37.0	63.0	38.1	61.9
MEAN									
8		6.0	32.2	19.1	19.0	13.6	24.5		
16		7.3	54.6	26.6	35.2	23.4	38.5		
LEADTIME									
2		5.1	31.9	19.3	17.7				
4		8.2	54.8	26.4	36.6				
C(FIX)/C(IN)									
32		6.2	39.6						
64		7.1	47.2						
LEADTIME	C(FIX)/C(IN)								
2	32	2.0	17.3						
2	64	3.1	14.6						
4	32	4.2	22.2						
4	64	4.0	32.6						

Table U9

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 38.6

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		14.0	35.9	26.1	28.4	23.5	30.6	23.8	30.4
MEAN									
	8	9.4	21.9	16.9	16.8	14.2	19.1		
	16	10.4	28.5	19.9	22.9	18.7	23.9		
LEADTIME									
	2	8.7	21.8	17.0	16.2				
	4	11.0	28.6	19.8	23.3				
C(FIX)/C(IN)									
	32	9.6	24.3						
	64	10.3	26.5						

LEADTIME	C(FIX)/C(IN)		
2	32	5.5	16.1
2	64	6.8	14.7
4	32	7.9	18.2
4	64	7.7	22.0

Table U10

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 28.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		10.2	26.2	19.4	20.3	18.7	21.0	19.0	20.7
MEAN									
8		6.9	17.7	13.3	13.6	13.4	13.5		
16		7.5	19.3	14.2	15.1	13.1	16.1		
LEADTIME									
2		6.9	17.4	12.2	14.2				
4		7.5	19.6	15.2	14.6				
C(FIX)/C(IN)									
32		6.5	18.3						
64		7.9	18.8						
LEADTIME	C(FIX)/C(IN)								
2	32	4.1	11.5						
2	64	5.6	13.1						
4	32	5.1	14.3						
4	64	5.5	13.5						

Table U11

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 27.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	9.8	25.7	13.2	20.6	16.3	22.2	14.4	23.4
MEAN								
8	6.2	13.0	10.4	9.9	6.7	12.8		
16	7.7	22.1	14.9	18.1	14.9	18.1		
LEADTIME								
2	5.4	15.4	12.8	10.0				
4	8.2	20.6	12.9	18.0				
C(FIX)/C(IN)								
32	6.9	16.9						
64	7.0	19.4						

LEADTIME	C(FIX)/C(IN)		
2	32	3.7	12.3
2	64	3.9	9.2
4	32	5.8	11.5
4	64	5.8	17.0

Table U12

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 6.5

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	4.4	4.7	4.1	5.0	4.5	4.6	4.1	5.0

MEAN						
8	2.9	2.9	2.2	3.4	2.9	2.9
16	3.4	3.7	3.4	3.7	3.5	3.6
LEADTIME						
2	3.0	3.3	2.9	3.4		
4	3.2	3.3	2.8	3.7		
C(FIX)/C(IN)						
32	2.8	3.0				
64	3.4	3.7				

LEADTIME	C(FIX)/C(IN)		
2	32	2.0	2.2
2	64	2.3	2.5
4	32	1.9	2.0
4	64	2.5	2.6

Table U13

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

S.D. OF BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1868

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1832	0.0368	0.1326	0.1317	0.1199	0.1433	0.1392	0.1247
MEAN									
	8	0.1368	0.0255	0.0968	0.1000	0.0828	0.1119		
	16	0.1218	0.0265	0.0906	0.0856	0.0867	0.0895		
LEADTIME									
	2	0.1171	0.0259	0.0862	0.0834				
	4	0.1409	0.0261	0.1007	0.1019				
C(FIX)/C(IN)									
	32	0.1303	0.0244						
	64	0.1288	0.0275						

LEADTIME	C(FIX)/C(IN)		
2	32	0.0842	0.0183
2	64	0.0813	0.0183
4	32	0.0994	0.0161
4	64	0.0998	0.0206

Table U14

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 10.8

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.5	13.3	11.5	10.2	8.5	12.8	11.0	10.7
MEAN								
8	7.1	13.2	11.9	10.1	8.7	13.0		
16	6.2	13.3	11.1	10.3	8.4	12.7		
LEADTIME								
2	4.2	11.0	9.3	7.8				
4	8.7	15.2	13.3	12.4				
C(FIX)/C(IN)								
32	7.5	13.7						
64	5.8	12.9						

LEADTIME	C(FIX)/C(IN)		
2	32	5.2	11.7
2	64	3.4	10.5
4	32	9.5	15.4
4	64	8.0	15.0

Table U15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 4.3

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.6	3.4	4.2	4.5	2.1	6.2	5.0	3.8
MEAN								
8	7.1	4.2	4.9	5.1	2.8	7.0		
16	6.2	2.8	3.7	4.0	1.5	5.6		
LEADTIME								
2	3.3	1.6	2.0	2.2				
4	9.4	4.9	5.9	6.5				
C(FIX)/C(IN)								
32	7.2	3.1						
64	6.2	3.8						

LEADTIME	C(FIX)/C(IN)		
2	32	3.8	1.3
2	64	2.9	1.8
4	32	9.7	4.4
4	64	9.0	5.4

Table U16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 52.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	17.7	81.0	53.4	50.9	47.2	56.0	52.2	52.0
MEAN								
8	18.3	82.6	54.7	49.8	49.3	54.4		
16	17.2	79.9	52.5	51.6	46.0	57.1		
LEADTIME								
2	13.7	76.2	48.1	46.4				
4	20.9	84.7	58.1	54.2				
C(FIX)/C(IN)								
32	19.3	81.4						
64	16.1	80.5						

LEADTIME	C(FIX)/C(IN)		
2	32	16.7	74.0
2	64	10.8	78.5
4	32	21.7	88.0
4	64	20.3	81.9

Table U17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 0.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.0	0.5	0.5	0.1	0.7	-0.2	0.5	0.1
MEAN									
8		0.3	0.8	0.3	0.7	1.4	-0.3		
16		-0.2	0.3	0.6	-0.4	0.2	-0.1		
LEADTIME									
2		0.4	1.0	0.7	0.6				
4		-0.4	0.0	0.3	-0.5				
C(FIX)/C(IN)									
32		0.1	0.9						
64		-0.1	0.2						
LEADTIME	C(FIX)/C(IN)								
2	32	0.2	1.2						
2	64	0.5	0.7						
4	32	0.1	0.5						
4	64	-0.7	-0.3						

Table U18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 8.1

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		4.2	69.8	9.7	6.6	6.3	10.0	8.1	8.1
MEAN									
8		4.5	69.0	8.8	7.5	7.7	8.4		
16		3.9	70.4	10.5	5.8	5.0	11.5		
LEADTIME									
2		2.7	64.1	7.9	4.6				
4		5.6	75.0	11.5	8.5				
C(FIX)/C(IN)									
32		5.7	71.9						
64		2.6	67.7						
LEADTIME	C(FIX)/C(IN)								
2	32	4.4	63.2						
2	64	0.9	65.1						
4	32	7.0	80.7						
4	64	4.3	69.9						

Table U19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 52.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	17.7	81.0	53.4	50.9	47.2	56.0	52.2	52.0
MEAN								
8	18.3	82.6	54.7	49.8	49.3	54.4		
16	17.2	79.9	52.5	51.6	46.0	57.1		
LEADTIME								
2	13.7	76.2	48.1	46.4				
4	20.9	84.7	58.1	54.2				
C(FIX)/C(IN)								
32	19.3	81.4						
64	16.1	80.5						

LEADTIME	C(FIX)/C(IN)		
2	32	16.7	74.0
2	64	10.8	78.5
4	32	21.7	88.0
4	64	20.3	81.9

Table U20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL III

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 0.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1	0.6	0.5	0.1	0.7	-0.0	0.5	0.2
MEAN									
8		0.2	0.7	0.3	0.7	1.4	-0.5		
16		-0.1	0.5	0.6	-0.4	0.2	0.2		
LEADTIME									
2		0.3	1.0	0.7	0.6				
4		-0.2	0.1	0.3	-0.5				
C(FIX)/C(IN)									
32		0.1	0.9						
64		-0.1	0.2						
LEADTIME	C(FIX)/C(IN)								
2	32	0.2	1.2						
2	64	0.5	0.7						
4	32	0.1	0.5						
4	64	-0.7	-0.3						

Appendix V

Multi-item Data for the Power Approximation

Model IV

System of 16 Items with Negative Binomial Demand Distributions

(Variance/Mean = 3) Controlled Optimally with Full Information.

		page
Table V1	Sources of Expected Total Cost	V1
V3	Sources of Aggregate Period-End Inventory	V2
V4	Sources of Aggregate Backlog Cost	V3
V5	Sources of Aggregate Replenishment Cost	V4
V6	Backlog Frequency	V5
V7	Weighted Proportion of Demand Backlogged	V6
V8	Replenishment Frequency	V7

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendix C.

Table VI

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 739.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.7	61.3	45.3	54.7	47.2	52.8	42.0	58.0
MEAN									
8		16.1	25.9	19.1	22.9	19.8	22.2		
16		22.6	35.4	26.2	31.8	27.4	30.6		
LEADTIME									
2		18.5	28.7	21.2	26.0				
4		20.2	32.5	24.1	28.7				
C(FIX)/C(IN)									
32		17.1	28.2						
64		21.6	33.1						
LEADTIME	C(FIX)/C(IN)								
2	32	8.1	13.1						
2	64	10.4	15.6						
4	32	9.0	15.1						
4	64	11.2	17.5						

Table V3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 433.6 PERCENT OF TOTAL COST= 58.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		30.2	69.8	47.0	53.0	45.9	54.1	42.1	57.9
MEAN									
8		12.6	29.5	19.8	22.3	19.3	22.8		
16		17.6	40.3	27.2	30.7	26.6	31.3		
LEADTIME									
2		13.9	32.0	21.4	24.5				
4		16.2	37.9	25.6	28.5				
C(FIX)/C(IN)									
32		13.7	33.3						
64		16.5	36.5						
LEADTIME	C(FIX)/C(IN)								
2	32	6.2	15.1						
2	64	7.7	16.8						
4	32	7.4	18.2						
4	64	8.8	19.7						

Table V4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 104.1 PERCENT OF TOTAL COST= 14.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	56.8	43.2	48.7	51.3	45.4	54.6	43.1	56.9
MEAN								
8	24.1	19.0	21.2	21.9	19.7	23.3		
16	32.7	24.2	27.5	29.4	25.7	31.3		
LEADTIME								
2	25.6	19.7	22.2	23.2				
4	31.1	23.5	26.5	28.1				
C(FIX)/C(IN)								
32	27.2	21.5						
64	29.6	21.8						

LEADTIME	C(FIX)/C(IN)		
2	32	12.3	9.9
2	64	13.3	9.9
4	32	14.9	11.6
4	64	16.2	11.9

Table V5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, OPTIMAL CONTROL(DP)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 201.5 PERCENT OF TOTAL COST= 27.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		47.8	52.2	39.9	60.1	51.1	48.9	41.2	58.8
MEAN									
	8	19.7	21.5	15.6	24.6	21.0	20.2		
	16	28.1	30.7	23.4	35.4	30.1	28.7		
LEADTIME									
	2	24.6	26.5	20.4	30.7				
	4	23.1	25.8	19.6	29.3				
C(FIX)/C(IN)									
	32	19.3	20.6						
	64	28.4	31.6						

LEADTIME	C(FIX)/C(IN)		
2	32	9.9	10.4
2	64	14.7	16.0
4	32	9.4	10.2
4	64	13.7	15.6

Table V6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, OPTIMAL CONTROL(DP)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1003

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.1913	0.0092	0.1001	0.1004	0.0996	0.1009	0.0997	0.1008
	8	0.1903	0.0091	0.1000	0.0994	0.0994	0.1000		
	16	0.1924	0.0093	0.1002	0.1014	0.0998	0.1018		
LEADTIME									
	2	0.1901	0.0091	0.0998	0.0995				
	4	0.1926	0.0092	0.1004	0.1013				
C(FIX)/C(IN)									
	32	0.1911	0.0092						
	64	0.1916	0.0092						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1903	0.0092
2	64	0.1899	0.0091
4	32	0.1918	0.0091
4	64	0.1934	0.0093

Table V7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, OPTIMAL CONTROL(DP)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0105

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	0.1540	0.0047	0.0102	0.0108	0.0096	0.0115	0.0136	0.0090
MEAN								
8	0.1959	0.0062	0.0134	0.0138	0.0125	0.0147		
16	0.1331	0.0040	0.0087	0.0093	0.0081	0.0099		
LEADTIME								
2	0.1391	0.0043	0.0093	0.0098				
4	0.1689	0.0051	0.0112	0.0118				
C(FIX)/C(IN)								
32	0.1475	0.0047						
64	0.1605	0.0048						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1334	0.0043
2	64	0.1448	0.0043
4	32	0.1617	0.0051
4	64	0.1761	0.0052

Table V8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, OPTIMAL CONTROL(DP)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2754

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.2640	0.2867	0.3143	0.2364	0.2813	0.2694	0.2273	0.3234
	8	0.2166	0.2381	0.2607	0.1940	0.2314	0.2233		
	16	0.3115	0.3353	0.3680	0.2788	0.3312	0.3155		
LEADTIME									
	2	0.2723	0.2903	0.3207	0.2419				
	4	0.2558	0.2831	0.3079	0.2309				
C(FIX)/C(IN)									
	32	0.3042	0.3245						
	64	0.2239	0.2489						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3131	0.3284
2	64	0.2315	0.2523
4	32	0.2953	0.3206
4	64	0.2164	0.2455

Appendix W

Multi-item Data for the Power Approximation

Model IV

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled Approximately Optimally with Full Information.

		page
Table W1	Sources of Expected Total Cost	W1
W3	Sources of Aggregate Period-End Inventory	W2
W4	Sources of Aggregate Backlog Cost	W3
W5	Sources of Aggregate Replenishment Cost	W4
W6	Backlog Frequency	W5
W7	Weighted Proportion of Demand Backlogged	W6
W8	Replenishment Frequency	W7
W15	Sources of Total Cost (% Excess Over DP)	W8
W16	Sources of Aggregate Period-End Inventory (% Excess Over DP)	W9
W17	Sources of Aggregate Backlog Cost (% Excess Over DP)	W10
W18	Sources of Aggregate Replenishment Cost (% Excess Over DP)	W11
W19	Backlog Frequency (% Excess Over DP)	W12
W20	Weighted Proportion of Demand Backlogged (% Excess Over DP)	W13
W21	Replenishment Frequency (% Excess Over DP)	W14

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices E and F.

Table W1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 758.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.4	61.6	45.1	54.9	47.1	52.9	42.1	57.9
MEAN									
	8	16.1	26.1	19.1	23.1	19.9	22.3		
	16	22.4	35.5	26.1	31.8	27.3	30.6		
LEADTIME									
	2	18.3	28.8	21.1	26.1				
	4	20.1	32.7	24.0	28.8				
C(FIX)/C(IN)									
	32	16.9	28.2						
	64	21.5	33.3						
LEADTIME	C(FIX)/C(IN)								
2	32	8.0	13.1						
2	64	10.3	15.7						
4	32	8.9	15.1						
4	64	11.2	17.6						

Table W3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 460.7 PERCENT OF TOTAL COST= 60.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		28.8	71.2	47.2	52.8	46.1	53.9	42.2	57.8
MEAN									
	8	11.9	30.3	20.0	22.2	19.5	22.7		
	16	16.9	40.9	27.1	30.7	26.6	31.2		
LEADTIME									
	2	13.4	32.7	21.5	24.6				
	4	15.4	38.5	25.6	28.3				
C(FIX)/C(IN)									
	32	13.3	33.9						
	64	15.6	37.3						

LEADTIME	C(FIX)/C(IN)		
2	32	6.1	15.4
2	64	7.3	17.3
4	32	7.2	18.5
4	64	8.2	20.0

Table W4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 96.8 PERCENT OF TOTAL COST= 12.8

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	58.7	41.3	47.5	52.5	45.4	54.6	42.8	57.2
MEAN								
8	25.4	17.4	19.4	23.5	19.6	23.3		
16	33.3	23.9	28.1	29.1	25.9	31.3		
LEADTIME								
2	26.8	18.6	21.6	23.9				
4	31.9	22.7	25.9	28.7				
C(FIX)/C(IN)								
32	27.8	19.6						
64	30.8	21.7						

LEADTIME	C(FIX)/C(IN)		
2	32	12.6	9.0
2	64	14.2	9.6
4	32	15.2	10.7
4	64	16.6	12.0

Table W5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 201.1 PERCENT OF TOTAL COST= 26.5

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.8	49.2	39.4	60.6	50.3	49.7	41.6	58.4
MEAN									
8		21.1	20.5	16.7	24.9	20.9	20.7		
16		29.6	28.7	22.7	35.7	29.4	28.9		
LEADTIME									
2		25.5	24.8	19.8	30.5				
4		25.3	24.4	19.5	30.2				
C(FIX)/C(IN)									
32		20.0	19.3						
64		30.7	29.9						
LEADTIME	C(FIX)/C(IN)								
2	32	10.1	9.7						
2	64	15.4	15.1						
4	32	9.9	9.6						
4	64	15.3	14.8						

Table W6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.0946

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	0.1814	0.0078	0.0933	0.0959	0.0943	0.0949	0.0949	0.0943
MEAN								
8	0.1823	0.0075	0.0914	0.0984	0.0944	0.0953		
16	0.1806	0.0081	0.0952	0.0935	0.0941	0.0946		
LEADTIME								
2	0.1809	0.0077	0.0929	0.0956				
4	0.1819	0.0079	0.0936	0.0962				
C(FIX)/C(IN)								
32	0.1790	0.0075						
64	0.1838	0.0081						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1784	0.0075
2	64	0.1834	0.0078
4	32	0.1797	0.0075
4	64	0.1842	0.0083

Table W7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0098

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1480	0.0042	0.0093	0.0103	0.0089	0.0107	0.0126	0.0084
MEAN									
	8	0.1920	0.0053	0.0114	0.0138	0.0115	0.0137		
	16	0.1259	0.0037	0.0083	0.0085	0.0076	0.0092		
LEADTIME									
	2	0.1351	0.0038	0.0084	0.0093				
	4	0.1608	0.0046	0.0101	0.0112				
C(FIX)/C(IN)									
	32	0.1403	0.0040						
	64	0.1556	0.0044						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1268	0.0037
2	64	0.1433	0.0039
4	32	0.1538	0.0043
4	64	0.1679	0.0049

Table W8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTPIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2737

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
MEAN		0.2780	0.2694	0.3092	0.2382	0.2756	0.2718	0.2291	0.3183
	8	0.2326	0.2256	0.2624	0.1958	0.2302	0.2280		
	16	0.3235	0.3132	0.3560	0.2806	0.3210	0.3156		
LEADTIME									
	2	0.2795	0.2717	0.3118	0.2395				
	4	0.2766	0.2671	0.3067	0.2370				
C(FIX)/C(IN)									
	32	0.3145	0.3039						
	64	0.2415	0.2349						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3171	0.3064
2	64	0.2419	0.2370
4	32	0.3120	0.3014
4	64	0.2412	0.2328

Table W15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL I7

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 2.6

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	1.9	3.1	2.2	3.0	2.4	2.8	2.9	2.4
MEAN								
8	2.2	3.4	2.4	3.3	2.7	3.1		
16	1.7	2.9	2.1	2.7	2.2	2.6		
LEADTIME								
2	1.6	2.9	2.0	2.7				
4	2.2	3.2	2.5	3.2				
C(FIX)/C(IN)								
32	1.4	2.7						
64	2.3	3.4						

LEADTIME	C(FIX)/C(IN)		
2	32	1.1	2.5
2	64	1.9	3.3
4	32	1.7	2.9
4	64	2.6	3.5

Table W16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 6.3

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	1.5	8.3	6.6	5.9	6.7	5.9	6.5	6.1
MEAN								
8	0.6	9.0	7.6	5.5	7.1	5.9		
16	2.1	7.9	5.9	6.3	6.5	5.8		
LEADTIME								
2	2.2	8.7	7.0	6.5				
4	0.9	8.0	6.3	5.4				
C(FIX)/C(IN)								
32	3.2	8.1						
64	0.0	8.6						

LEADTIME	C(FIX)/C(IN)		
2	32	3.9	8.3
2	64	0.7	9.2
4	32	2.6	7.9
4	64	-0.6	8.1

Table W17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -7.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-3.9	-11.1	-9.3	-4.9	-7.0	-7.0	-7.5	-6.6
MEAN								
8	-2.0	-14.6	-14.9	-0.4	-7.8	-7.3		
16	-5.4	-8.3	-4.9	-8.2	-6.3	-6.8		
LEADTIME								
2	-2.9	-12.3	-9.6	-4.5				
4	-4.8	-10.1	-9.0	-5.2				
C(FIX)/C(IN)								
32	-4.9	-14.9						
64	-3.0	-7.3						

LEADTIME	C(FIX)/C(IN)		
2	32	-4.9	-15.4
2	64	-1.1	-9.1
4	32	-4.9	-14.4
4	64	-4.7	-5.8

Table W18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.1	-5.9	-1.6	0.8	-1.7	1.4	0.8	-0.9
MEAN								
8	7.2	-5.0	0.7	0.9	-0.9	2.6		
16	5.3	-6.5	-3.3	0.7	-2.3	0.6		
LEADTIME								
2	3.2	-6.3	-2.8	-1.0				
4	9.1	-5.5	-0.4	2.6				
C(FIX)/C(IN)								
32	3.4	-6.3						
64	7.9	-5.6						

LEADTIME	C(FIX)/C(IN)		
2	32	1.3	-6.7
2	64	4.5	-6.1
4	32	5.7	-6.0
4	64	11.5	-5.2

Table W19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -5.6

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		-5.2	-15.0	-8.8	-4.5	-5.4	-5.9	-4.8	-6.4
MEAN									
8		-4.2	-17.8	-8.6	-1.1	-5.0	-4.7		
16		-6.1	-12.3	-5.0	-7.8	-5.7	-7.1		
LEADTIME									
2		-4.9	-16.0	-6.9	-3.9				
4		-5.5	-14.0	-6.8	-5.0				
C(FIX)/C(IN)									
32		-6.3	-18.0						
64		-4.1	-12.0						
LEADTIME	C(FIX)/C(IN)								
2	32	-6.3	-18.7						
2	64	-3.4	-13.4						
4	32	-6.3	-17.4						
4	64	-4.8	-10.7						

Table W20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -7.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-3.9	-11.1	-9.3	-4.9	-7.0	-7.0	-7.5	-6.6
MEAN								
8	-2.0	-14.6	-14.9	-0.4	-7.8	-7.3		
16	-5.4	-8.3	-4.9	-8.2	-6.3	-6.8		
LEADTIME								
2	-2.9	-12.3	-9.6	-4.5				
4	-4.8	-10.1	-9.0	-5.2				
C(FIX)/C(IN)								
32	-4.9	-14.9						
64	-3.0	-7.3						

LEADTIME	C(FIX)/C(IN)		
2	32	-4.9	-15.4
2	64	-1.1	-9.1
4	32	-4.9	-14.4
4	64	-4.7	-5.8

Table W21

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FULL INFORMATION, APPROXIMATELY OPTIMAL CONTROL (PA)

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -0.6

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		5.3	-6.0	-1.6	0.8	-2.0	0.9	0.8	-1.6
MEAN									
8		7.4	-5.3	0.7	0.9	-0.5	2.1		
16		3.8	-6.6	-3.3	0.7	-3.1	0.0		
LEADTIME									
2		2.7	-6.4	-2.8	-1.0				
4		8.1	-5.6	-0.4	2.6				
C(FIX)/C(IN)									
32		3.4	-6.3						
64		7.9	-5.6						
LEADTIME	C(FIX)/C(IN)								
2	32	1.3	-6.7						
2	64	4.5	-6.1						
4	32	5.7	-6.0						
4	64	11.5	-5.2						

Appendix X

Multi-item Data for the (24,24) Statistical Power Approximation

Model IV

System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information from a 24-Period Demand History, with Revision Every 24 Periods, Using Regression Estimates of Demand Means and Variances.

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Table X1	Sources of Total Cost	X1
X3	Sources of Aggregate Period-End Inventory	X2
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X6	Backlog Frequency	X5
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X17	Sources of Aggregate Backlog Cost (% Excess Over DP)	X10
X18	Sources of Aggregate Replenishment Cost (% Excess Over DP)	X11
X19	Backlog Frequency (% Excess Over DP)	X12
X20	Weighted Proportion of Demand Backlogged (% Excess Over DP)	X13
X21	Replenishment Frequency (% Excess Over DP)	X14

Note: For corresponding data in MacCormick (1974), see the table of the same number in his Appendices K and L.

Table X1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 817.9

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		37.2	62.8	45.7	54.3	46.5	53.5	42.4	57.6
MEAN									
8		15.6	26.8	19.4	22.9	19.7	22.7		
16		21.6	36.0	26.2	31.4	26.8	30.9		
LEADTIME									
2		17.5	28.9	21.0	25.4				
4		19.7	33.8	24.7	28.9				
C(FIX)/C(IN)									
32		16.5	29.2						
64		20.7	33.6						
LEADTIME	C(FIX)/C(IN)								
2	32	7.7	13.3						
2	64	9.8	15.6						
4	32	8.8	15.9						
4	64	10.9	18.0						

Table X3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 491.7 PERCENT OF TOTAL COST= 60.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	29.2	70.8	47.1	52.9	45.6	54.4	42.7	57.3
MEAN								
8	12.2	30.5	20.4	22.3	19.5	23.2		
16	17.0	40.3	26.8	30.6	26.1	31.2		
LEADTIME								
2	13.3	32.3	21.2	24.4				
4	15.9	38.5	25.9	28.4				
C(FIX)/C(IN)								
32	13.4	33.8						
64	15.8	37.1						

LEADTIME	C(FIX)/C(IN)		
2	32	6.0	15.2
2	64	7.3	17.1
4	32	7.4	18.6
4	64	8.5	20.0

Table X4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 124.1 PERCENT OF TOTAL COST= 15.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		46.9	53.1	49.6	50.4	43.1	56.9	42.7	57.3
MEAN									
8		20.3	22.4	20.3	22.4	18.6	24.1		
16		26.6	30.7	29.3	28.0	24.5	32.8		
LEADTIME									
2		20.9	22.2	21.4	21.7				
4		26.0	30.9	28.2	28.7				
C(FIX)/C(IN)									
32		22.7	26.9						
64		24.2	26.2						
LEADTIME	C(FIX)/C(IN)								
2	32	10.1	11.3						
2	64	10.9	10.9						
4	32	12.6	15.6						
4	64	13.3	15.3						

Table X5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 202.1 PERCENT OF TOTAL COST= 24.7

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.9	49.1	39.8	60.2	50.5	49.5	41.4	58.6
MEAN									
8		21.1	20.3	16.6	24.8	20.8	20.6		
16		29.7	28.8	23.1	35.5	29.8	28.8		
LEADTIME									
2		25.6	24.9	20.3	30.2				
4		25.2	24.2	19.4	30.0				
C(FIX)/C(IN)									
32		20.2	19.6						
64		30.7	29.6						
LEADTIME	C(FIX)/C(IN)								
2	32	10.3	10.0						
2	64	15.4	14.9						
4	32	9.9	9.5						
4	64	15.3	14.7						

Table X6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.0947

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1781	0.0114	0.0948	0.0947	0.0936	0.0959	0.0950	0.0945
MEAN									
	8	0.1790	0.0110	0.0923	0.0978	0.0939	0.0962		
	16	0.1772	0.0118	0.0973	0.0916	0.0933	0.0957		
LEADTIME									
	2	0.1765	0.0106	0.0935	0.0936				
	4	0.1797	0.0122	0.0960	0.0958				
C(FIX)/C(IN)									
	32	0.1780	0.0116						
	64	0.1782	0.0112						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1762	0.0109
2	64	0.1769	0.0103
4	32	0.1798	0.0123
4	64	0.1795	0.0121

Table X7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0126

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1516	0.0069	0.0125	0.0126	0.0108	0.0143	0.0161	0.0108
MEAN									
	8	0.1964	0.0088	0.0153	0.0169	0.0140	0.0181		
	16	0.1292	0.0060	0.0111	0.0105	0.0092	0.0124		
LEADTIME									
	2	0.1353	0.0058	0.0107	0.0109				
	4	0.1679	0.0081	0.0142	0.0144				
C(FIX)/C(IN)									
	32	0.1468	0.0070						
	64	0.1563	0.0068						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1302	0.0059
2	64	0.1403	0.0057
4	32	0.1635	0.0081
4	64	0.1724	0.0080

Table X8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2759

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2806	0.2711	0.3139	0.2379	0.2798	0.2720	0.2292	0.3226
MEAN									
	8	0.2339	0.2245	0.2627	0.1957	0.2302	0.2282		
	16	0.3274	0.3178	0.3651	0.2800	0.3293	0.3158		
LEADTIME									
	2	0.2837	0.2758	0.3208	0.2387				
	4	0.2775	0.2665	0.3070	0.2370				
C(FIX)/C(IN)									
	32	0.3191	0.3087						
	64	0.2422	0.2335						

LEADTIME	C(FIX)/C(IN)		
2	32	0.3250	0.3167
2	64	0.2425	0.2349
4	32	0.3131	0.3008
4	64	0.2419	0.2322

Table X15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 10.6

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.4	13.3	11.6	9.9	8.8	12.3	11.6	9.9
MEAN								
8	7.1	14.4	12.6	10.8	9.8	13.3		
16	5.8	12.5	10.8	9.2	8.0	11.6		
LEADTIME								
2	4.6	11.4	9.6	8.1				
4	8.0	15.0	13.4	11.4				
C(FIX)/C(IN)								
32	6.5	14.6						
64	6.2	12.2						

LEADTIME	C(FIX)/C(IN)		
2	32	4.8	12.5
2	64	4.5	10.6
4	32	8.1	16.5
4	64	7.8	13.8

Table X16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 13.4

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	9.6	15.0	13.7	13.1	12.7	14.0	15.0	12.3
MEAN								
8	9.8	17.1	16.8	13.3	14.5	15.3		
16	9.5	13.5	11.5	12.9	11.3	13.1		
LEADTIME								
2	8.1	14.7	12.4	12.9				
4	10.9	15.3	14.8	13.3				
C(FIX)/C(IN)								
32	11.0	14.9						
64	8.5	15.2						

LEADTIME	C(FIX)/C(IN)		
2	32	8.9	13.9
2	64	7.5	15.4
4	32	12.8	15.7
4	64	9.4	15.0

Table X17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 19.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	-1.6	46.4	21.5	17.0	13.1	24.2	18.2	19.9
MEAN								
8	0.3	40.9	14.1	22.1	12.4	23.0		
16	-2.9	50.8	27.2	13.1	13.6	25.1		
LEADTIME								
2	-2.8	33.7	14.9	11.4				
4	-0.6	57.1	27.1	21.5				
C(FIX)/C(IN)								
32	-0.5	49.4						
64	-2.6	43.5						

LEADTIME	C(FIX)/C(IN)		
2	32	-2.4	36.4
2	64	-3.1	31.1
4	32	1.1	60.5
4	64	-2.2	53.8

Table X18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.3

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	6.8	-5.7	-0.1	0.6	-0.8	1.5	0.8	-0.0
MEAN								
8	7.8	-5.5	0.8	0.8	-0.9	2.6		
16	6.2	-5.8	-0.8	0.4	-0.7	0.6		
LEADTIME								
2	4.4	-5.6	0.0	-1.3				
4	9.5	-5.7	-0.3	2.6				
C(FIX)/C(IN)								
32	4.9	-4.9						
64	8.2	-6.2						

LEADTIME	C(FIX)/C(IN)		
2	32	3.8	-3.6
2	64	4.8	-6.9
4	32	6.1	-6.2
4	64	11.8	-5.4

Table X19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= -5.5

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		-6.9	24.0	-5.3	-5.7	-6.1	-4.9	-4.7	-6.3
MEAN									
8		-5.9	21.2	-7.7	-1.7	-5.6	-3.8		
16		-7.9	26.8	-2.9	-9.6	-6.6	-6.0		
LEADTIME									
2		-7.1	16.1	-6.3	-5.9				
4		-6.7	31.9	-4.4	-5.5				
C(FIX)/C(IN)									
32		-6.8	26.1						
64		-7.0	21.9						
LEADTIME	C(FIX)/C(IN)								
2	32	-7.4	18.0						
2	64	-6.8	14.1						
4	32	-6.2	34.3						
4	64	-7.2	29.5						

Table X20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 19.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		-1.6	46.4	21.5	17.0	13.1	24.2	18.2	19.9
MEAN									
	8	0.3	40.9	14.1	22.1	12.4	23.0		
	16	-2.9	50.8	27.2	13.1	13.6	25.1		
LEADTIME									
	2	-2.8	33.7	14.9	11.4				
	4	-0.6	57.1	27.1	21.5				
C(FIX)/C(IN)									
	32	-0.5	49.4						
	64	-2.6	43.5						

LEADTIME	C(FIX)/C(IN)		
2	32	-2.4	36.4
2	64	-3.1	31.1
4	32	1.1	60.5
4	64	-2.2	53.8

Table X21

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

STATISTICAL INFORMATION FROM 24-PERIOD DEMAND HISTORY USED FOR CONTROLS, REVISED EVERY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% EXCESS OVER DP)

OVERALL AGGREGATE FOR SYSTEM= 0.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		6.3	-5.4	-0.1	0.6	-0.5	1.0	0.8	-0.3
MEAN									
8		8.0	-5.7	0.8	0.8	-0.5	2.2		
16		5.1	-5.2	-0.8	0.4	-0.6	0.1		
LEADTIME									
2		4.2	-5.0	0.0	-1.3				
4		8.5	-5.9	-0.3	2.6				
C(FIX)/C(IN)									
32		4.9	-4.9						
64		8.2	-6.2						
LEADTIME	C(FIX)/C(IN)								
2	32	3.8	-3.6						
2	64	4.8	-6.9						
4	32	6.1	-6.2						
4	64	11.8	-5.4						

Appendix Y

Multi-item Forecasts for the (24,24) Statistical Power Approximation

Model IV

Forecasting Properties of Inventory System of 16 Items with Negative Binomial Demand Distributions (Variance/Mean = 3) Controlled with Statistical Information, Revision Taking Place Every 24 Periods Using a 24-Period Demand History and Regression Estimates of Demand Means and Variances. Forecasts Made at Each Revision Using a 24-Period Demand History.

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Table Y1	Sources of Forecast of Total Cost	Y1
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Y19	Weighted Proportion of Demand Backlogged (% Underestimate of Actual by Forecast)	Y19
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Note: The corresponding appendices in MacCormick (1974), are his appendices T and U.

Table Y1

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 739.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		38.8	61.2	44.9	55.1	47.5	52.5	42.2	57.8
MEAN									
8		16.2	26.0	19.0	23.2	20.0	22.2		
16		22.6	35.2	25.9	31.9	27.6	30.3		
LEADTIME									
2		18.7	28.9	21.2	26.3				
4		20.1	32.4	23.7	28.7				
C(FIX)/C(IN)									
32		17.0	27.9						
64		21.8	33.3						
LEADTIME	C(FIX)/C(IN)								
2	32	8.1	13.1						
2	64	10.5	15.8						
4	32	8.9	14.9						
4	64	11.3	17.5						

Table Y2

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 470.4 PERCENT OF TOTAL COST= 63.6

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	28.3	71.7	46.9	53.1	46.3	53.7	42.6	57.4
MEAN								
8	11.8	30.8	20.2	22.4	19.8	22.8		
16	16.6	40.8	26.7	30.7	26.5	30.9		
LEADTIME								
2	13.3	33.0	21.4	24.8				
4	15.1	38.7	25.5	28.2				
C(FIX)/C(IN)								
32	13.0	34.0						
64	15.4	37.7						

LEADTIME	C(FIX)/C(IN)		
2	32	6.0	15.5
2	64	7.3	17.5
4	32	7.0	18.5
4	64	8.1	20.1

Table Y3

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 66.9 PERCENT OF TOTAL COST= 9.0

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	76.0	24.0	46.4	53.6	47.7	52.3	41.5	58.5
MEAN								
8	32.2	9.3	18.0	23.5	18.9	22.6		
16	43.8	14.7	28.4	30.1	28.8	29.7		
LEADTIME								
2	35.9	11.8	22.6	25.1				
4	40.1	12.2	23.8	28.6				
C(FIX)/C(IN)								
32	35.4	11.0						
64	40.6	13.1						

LEADTIME	C(FIX)/C(IN)		
2	32	17.0	5.6
2	64	18.9	6.2
4	32	18.4	5.3
4	64	21.7	6.9

Table Y4

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 202.0 PERCENT OF TOTAL COST= 27.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		50.8	49.2	39.8	60.2	50.4	49.6	41.4	58.6
MEAN									
	8	21.1	20.3	16.6	24.8	20.7	20.7		
	16	29.7	28.9	23.2	35.4	29.7	28.9		
LEADTIME									
	2	25.6	24.8	20.2	30.2				
	4	25.2	24.3	19.6	30.0				
C(FIX)/C(IN)									
	32	20.3	19.5						
	64	30.5	29.7						

LEADTIME	C(FIX)/C(IN)		
2	32	10.3	9.9
2	64	15.3	14.9
4	32	10.0	9.6
4	64	15.3	14.8

Table Y5

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.0892

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	0.1742	0.0042	0.0875	0.0909	0.0897	0.0886	0.0888	0.0895
MEAN								
8	0.1740	0.0036	0.0838	0.0939	0.0892	0.0884		
16	0.1743	0.0047	0.0911	0.0879	0.0903	0.0887		
LEADTIME								
2	0.1754	0.0041	0.0891	0.0904				
4	0.1729	0.0043	0.0858	0.0914				
C(FIX)/C(IN)								
32	0.1710	0.0040						
64	0.1773	0.0044						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1743	0.0040
2	64	0.1766	0.0042
4	32	0.1677	0.0040
4	64	0.1781	0.0046

Table Y6

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED

OVERALL AGGREGATE FOR SYSTEM= 0.0068

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1323	0.0017	0.0063	0.0073	0.0064	0.0071	0.0084	0.0059
MEAN									
	8	0.1681	0.0020	0.0073	0.0095	0.0077	0.0092		
	16	0.1144	0.0016	0.0058	0.0061	0.0058	0.0060		
LEADTIME									
	2	0.1250	0.0017	0.0061	0.0068				
	4	0.1396	0.0017	0.0064	0.0077				
C(FIX)/C(IN)									
	32	0.1233	0.0015						
	64	0.1412	0.0018						

LEADTIME	C(FIX)/C(IN)		
2	32	0.1183	0.0016
2	64	0.1316	0.0017
4	32	0.1283	0.0015
4	64	0.1509	0.0019

Table Y7

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.2758

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.2806	0.2709	0.3140	0.2376	0.2788	0.2728	0.2288	0.3228
	MEAN								
	8	0.2334	0.2242	0.2618	0.1958	0.2290	0.2286		
	16	0.3279	0.3177	0.3662	0.2793	0.3286	0.3169		
	LEADTIME								
	2	0.2832	0.2744	0.3193	0.2383				
	4	0.2781	0.2674	0.3087	0.2368				
	C(FIX)/C(IN)								
	32	0.3202	0.3078						
	64	0.2410	0.2341						
LEADTIME	C(FIX)/C(IN)								
2	32	0.3250	0.3135						
2	64	0.2413	0.2353						
4	32	0.3154	0.3020						
4	64	0.2407	0.2329						

Table Y8

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF VARIANCE OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 1239.2

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		15.9	84.1	42.3	57.7	44.9	55.1	37.9	62.1
MEAN									
	8	6.7	31.2	16.2	21.7	14.4	23.6		
	16	9.2	52.9	26.1	36.0	30.6	31.5		
LEADTIME									
	2	5.5	39.5	17.3	27.7				
	4	10.4	44.6	25.1	30.0				
C(FIX)/C(IN)									
	32	7.8	34.6						
	64	8.1	49.5						

LEADTIME	C(FIX)/C(IN)		
2	32	2.5	14.8
2	64	3.0	24.7
4	32	5.3	19.8
4	64	5.2	24.8

Table Y9

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF TOTAL COST

OVERALL AGGREGATE FOR SYSTEM= 35.2

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	14.0	32.3	22.9	26.7	23.6	26.1	21.7	27.7
MEAN								
8	9.1	19.7	14.2	16.4	13.3	17.1		
16	10.7	25.6	18.0	21.1	19.5	19.8		
LEADTIME								
2	8.2	22.1	14.6	18.5				
4	11.4	23.5	17.6	19.3				
C(FIX)/C(IN)								
32	9.8	20.7						
64	10.0	24.8						

LEADTIME	C(FIX)/C(IN)		
2	32	5.6	13.5
2	64	6.1	17.5
4	32	8.1	15.7
4	64	8.0	17.5

Table Y10

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE PERIOD-END INVENTORY

OVERALL AGGREGATE FOR SYSTEM= 24.4

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		8.8	22.8	17.2	17.3	14.7	19.5	16.1	18.3
MEAN									
	8	5.9	15.0	11.2	11.5	9.9	12.7		
	16	6.5	17.2	13.1	12.9	10.9	14.8		
LEADTIME									
	2	5.1	13.8	10.4	10.4				
	4	7.1	18.1	13.8	13.8				
C(FIX)/C(IN)									
	32	6.0	16.2						
	64	6.4	16.1						

LEADTIME	C(FIX)/C(IN)		
2	32	3.4	9.8
2	64	3.8	9.7
4	32	4.9	12.9
4	64	5.1	12.8

Table Y11

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE BACKLOG COST

OVERALL AGGREGATE FOR SYSTEM= 26.3

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		10.4	24.2	16.4	20.6	18.5	18.8	15.1	21.6
MEAN									
	8	6.4	13.7	9.3	11.9	9.1	12.1		
	16	8.2	20.0	13.5	16.8	16.0	14.4		
LEADTIME									
	2	5.7	17.6	11.1	14.8				
	4	8.7	16.7	12.1	14.4				
C(FIX)/C(IN)									
	32	7.3	14.6						
	64	7.4	19.3						

LEADTIME	C(FIX)/C(IN)		
2	32	3.8	10.4
2	64	4.2	14.2
4	32	6.2	10.3
4	64	6.1	13.0

Table Y12

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF S.D. OF AGGREGATE REPLENISHMENT COST

OVERALL AGGREGATE FOR SYSTEM= 5.9

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	4.0	4.3	3.5	4.8	4.3	4.0	3.9	4.4
MEAN								
8	2.7	2.9	2.1	3.4	2.7	2.8		
16	3.0	3.2	2.8	3.4	3.3	2.9		
LEADTIME								
2	2.9	3.2	2.7	3.4				
4	2.8	2.9	2.2	3.4				
C(FIX)/C(IN)								
32	2.3	2.6						
64	3.3	3.4						

LEADTIME	C(FIX)/C(IN)		
2	32	1.8	2.0
2	64	2.3	2.4
4	32	1.6	1.6
4	64	2.3	2.4

Table Y13

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

S.D. OF BACKLOG FREQUENCY

OVERALL AGGREGATE FOR SYSTEM= 0.1844

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.1803	0.0387	0.1296	0.1312	0.1212	0.1390	0.1357	0.1248
MEAN									
	8	0.1331	0.0262	0.0935	0.0984	0.0890	0.1024		
	16	0.1216	0.0285	0.0898	0.0868	0.0822	0.0940		
LEADTIME									
	2	0.1184	0.0256	0.0851	0.0863				
	4	0.1359	0.0291	0.0978	0.0988				
C(FIX)/C(IN)									
	32	0.1268	0.0267						
	64	0.1281	0.0281						

LEADTIME	C(FIX)/C(IN)		
2	32	0.0832	0.0176
2	64	0.0842	0.0186
4	32	0.0957	0.0201
4	64	0.0965	0.0210

Table Y14

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF TOTAL COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 9.6

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	5.8	11.9	11.1	8.4	7.5	11.4	10.1	9.3
MEAN								
8	6.4	12.2	11.6	8.8	8.4	11.5		
16	5.4	11.6	10.7	8.1	6.9	11.4		
LEADTIME								
2	3.6	9.9	8.8	6.5				
4	7.8	13.6	13.1	10.0				
C(FIX)/C(IN)								
32	6.7	13.6						
64	5.1	10.4						

LEADTIME	C(FIX)/C(IN)		
2	32	4.0	11.5
2	64	3.2	8.6
4	32	9.1	15.3
4	64	6.7	12.0

Table Y15

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE PERIOD-END INVENTORY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 4.3

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	7.0	3.2	4.7	4.0	3.0	5.5	4.5	4.2
MEAN								
8	7.5	3.4	5.1	4.0	3.0	5.9		
16	6.7	3.1	4.4	4.0	3.0	5.2		
LEADTIME								
2	4.6	2.3	3.3	2.7				
4	9.1	4.0	5.8	5.1				
C(FIX)/C(IN)								
32	7.2	3.7						
64	6.9	2.7						

LEADTIME	C(FIX)/C(IN)		
2	32	4.7	2.7
2	64	4.4	1.9
4	32	9.1	4.5
4	64	9.1	3.4

Table Y16

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE BACKLOG COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 46.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	12.7	75.6	49.6	42.7	40.4	50.5	47.6	45.0
MEAN								
8	14.4	77.6	52.1	43.6	45.3	49.5		
16	11.5	74.1	47.9	41.9	36.7	51.2		
LEADTIME								
2	7.6	71.4	43.0	37.8				
4	16.9	78.7	54.7	46.3				
C(FIX)/C(IN)								
32	16.0	78.1						
64	9.7	73.1						

LEADTIME	C(FIX)/C(IN)		
2	32	9.1	73.2
2	64	6.3	69.4
4	32	21.5	81.6
4	64	12.5	75.7

Table Y17

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

SOURCES OF AGGREGATE REPLENISHMENT COST
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 0.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	0.1	-0.0	-0.0	0.1	0.3	-0.2	0.1	0.0
MEAN								
8	0.2	-0.0	0.4	-0.1	0.4	-0.2		
16	0.1	0.0	-0.3	0.3	0.2	-0.1		
LEADTIME								
2	0.3	0.3	0.5	0.2				
4	0.0	-0.3	-0.6	0.1				
C(FIX)/C(IN)								
32	-0.4	0.3						
64	0.5	-0.2						

LEADTIME	C(FIX)/C(IN)		
2	32	-0.0	1.0
2	64	0.5	-0.2
4	32	-0.7	-0.4
4	64	0.5	-0.3

Table Y18

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

BACKLOG FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 5.9

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	2.2	63.4	7.7	4.1	4.1	7.6	6.5	5.3
MEAN								
8	2.8	66.9	9.2	4.0	4.9	8.0		
16	1.6	60.1	6.3	4.1	3.3	7.2		
LEADTIME								
2	0.6	61.7	4.7	3.5				
4	3.8	64.9	10.6	4.6				
C(FIX)/C(IN)								
32	3.9	65.7						
64	0.5	60.9						

LEADTIME	C(FIX)/C(IN)		
2	32	1.1	63.5
2	64	0.2	59.7
4	32	6.8	67.7
4	64	0.8	62.0

Table Y19

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

WEIGHTED PROPORTION OF DEMAND BACKLOGGED
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 46.1

	C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
	4	99	32	64	2	4	8	16
	12.7	75.6	59.6	42.7	40.4	50.5	47.6	45.0
MEAN								
8	14.4	77.6	52.1	43.6	45.3	49.5		
16	11.5	74.1	47.9	41.9	36.7	51.2		
LEADTIME								
2	7.6	71.4	43.0	37.8				
4	16.9	78.7	54.7	46.3				
C(FIX)/C(IN)								
32	16.0	78.1						
64	9.7	73.1						

LEADTIME	C(FIX)/C(IN)		
2	32	9.1	73.2
2	64	6.3	69.4
4	32	21.5	81.6
4	64	12.5	75.7

Table Y20

SYSTEM OF 16 ITEMS WITH NEGATIVE BINOMIAL DEMAND DISTRIBUTIONS
MODEL IV

FORECASTS, MADE EVERY 24 PERIODS, USING A 24-PERIOD HISTORY; CONTROL REVISION HISTORY 24 PERIODS
USING REGRESSION ESTIMATES OF DEMAND MEANS AND VARIANCES

REPLENISHMENT FREQUENCY
(% UNDERESTIMATE OF ACTUAL)

OVERALL AGGREGATE FOR SYSTEM= 0.0

		C(OUT)/C(IN)		C(FIX)/C(IN)		LEADTIME		MEAN	
		4	99	32	64	2	4	8	16
		0.0	0.1	-0.0	0.1	0.3	-0.3	0.2	-0.1
MEAN									
8		0.2	0.1	0.4	-0.1	0.5	-0.2		
16		-0.1	0.0	-0.3	0.3	0.2	-0.3		
LEADTIME									
2		0.2	0.5	0.5	0.2				
4		-0.2	-0.4	-0.6	0.1				
C(FIX)/C(IN)									
32		-0.4	0.3						
64		0.5	-0.2						
LEADTIME	C(FIX)/C(IN)								
2	32	-0.0	1.0						
2	64	0.5	-0.2						
4	32	-0.7	-0.4						
4	64	0.5	-0.3						