Quantitative Analysis

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CHAPTER-11
QUANTITATIVE ANALYSIS

→ The techniques used in analyzing the problem which involve the use of numbers, symbols and mathematical expression are the Quantitative anaysis or techniques.

→ Quantitative techniques are those statistical or programming techniques which provide the decision maker with a systematic and powerful means of analysis and help, based on quantitative data, in exploring polices for achieving pre-determined goals.

→ The decision making also known as decision analysis is the option to be selected by the decision maker for the determination of optimal strategy from the various options available to him.

* Types of Decision Making Environment:
  1. Decision making under certainty
  2. Decision making under Risk
  3. Decision making under Uncertainty

* Decision making under Uncertainty:
  a. Maximax Criteria (Optimistic)
  b. Maximin Criteria (Pessimistic)
  c. Minimax Regret Criteria

  Where,
  Maximax = Maximum from maximum
  Maximin = Maximum from Minimum
  Minimax = Minimum from Maximum

* Payoff: The benefit obtained from the given combination of decision alternative and the state of nature is known as the pay off.

* Regret Value: A quantitative measure of loss obtained by substrating a particular pay-off from the highest pay-off both belonging to the same state of nature, is known as the regret value of particular payoff.

Formula:

1. Payoff = Unit sold X MP [If $D \geq S$]

2. Payoff = Unit sold X MP − Unit unsold X ML [If $D < S$]

Where,

MP = Marginal profit = Selling price (SP) - Cost price (CP)

ML = Marginal loss = Cost price (CP) - Scrap value (SV)

For example:

Cost price (CP) = Rs. 10

Selling price (SP) = Rs. 15

Scrap value (SV) = Rs. 1

Marginal profit (MP) = ?

Marginal Loss (ML) = ?

MP = SP - CP = 15 - 10 = Rs. 5

ML = CP - SV = 10 - 1 = Rs. 9

2077 Back & No.6

Soln

(a) Maximax Criterion

Payoff Table

Strategy	State of nature (Pay-off in Rs.)			Maximax Criterion
	N_1	N_2	N_3	Maximum pay-off
S_1	70	30	15	70 (Maximum)
S_2	50	45	10	50
S_3	30	40	20	40

∴ The maximum pay-off out of maximum is 70 which is correspond to S_1. So, according to maximax criterion, decision maker should select strategy S_1.

(b) Minimax Criterion

Regret Table

Strategy	State of Nature (Regret in Rs.)			MiniMax Criterion
	N_1	N_2	N_3	Maximum Regret
S_1	70 - 70 = 0	45 - 30 = 15	20 - 15 = 5	15 (Minimum)
S_2	70 - 50 = 20	45 - 45 = 0	20 - 10 = 10	20
S_3	70 - 30 = 40	45 - 40 = 5	20 - 20 = 0	40

∴ The minimum out of maximum regret is 15 which is correspond to S_1. So, according to Minimax criterion, the decision maker should select strategy S_1.

2076 Q.No.5 / 2075 Q.No.6

Sol^n

Regret Table

Demand (Units)	Decision Alternatives			
	15	16	17	18
15	150-150=0	150-120=30	150-90=60	150-60=90
16	160-150=10	160-160=0	160-130=30	160-100=60
17	170-150=20	170-160=10	170-170=0	170-140=30
18	180-150=30	180-160=20	180-170=10	180-180=0

2078 Q.No.15(b)

Sol^n

(a) For Maximax Criterion (b) For Maximin Criterion

Strategy	State of Nature					Maximax	Maximin
	$N_1(10)$	$N_2(11)$	$N_3(12)$	$N_4(13)$	$N_5(14)$	Maximum payoff	Minimum payoffs
$S_1(10)$	400	400	400	400	400	400	[400] Max.
$S_2(11)$	380	440	440	440	440	440	380
$S_3(12)$	360	420	480	480	480	480	360
$S_4(13)$	340	400	460	520	520	520	340
$S_5(14)$	320	380	440	500	560	[560] Max.	320

Decision:

Maximax Criterion: The maximum payoff outoff maximum is 560 which is correspond to S_5. So, according to maximax criterion the decision maker should select strategy S_5.

Maximin Criterion: The maximum out off minimum payoff is 400 which is corresponding to S_1. So, according to maximin criterion, the decision maker should select strategy S_1.

(c) Minimax Criterion:

Regret Table

Strategy	State of Nature					Minimax
	N_1 (10)	N_2 (11)	N_3 (12)	N_4 (13)	N_5 (14)	Maximum
S_1 (10)	400-400=0	440-400=40	480-400=80	520-400=120	560-400=160	160
S_2 (11)	400-380=20	440-440=0	480-440=40	520-440=80	560-440=120	120
S_3 (12)	400-360=40	440-420=20	480-480=0	520-480=40	560-480=80	80
S_4 (13)	400-340=60	440-400=40	480-460=20	520-520=0	560-520=40	60 Min.
S_5 (14)	400-320=80	440-380=60	480-440=40	520-500=20	560-560=0	80

Decision:

Minimax Criterion: The minimum out of maximum regret is 60 which is corresponding to S_4. So, according to minimax criterion, the decision maker should select strategy S_4.

2063 Q.NO. 3 b (old)

Soln

Payoff Table

Strategy	States of nature				Optimistic (Maximax)	Pessimistic (Maximin)
	N_1(20)	N_2(21)	N_3(22)	N_4(23)	Maximum	Minimum
S_1(20)	200	200	200	200	200	200 (Max.)
S_2(21)	180	210	210	210	210	180
S_3(22)	160	190	220	220	220	160
S_4(23)	140	170	200	230	230 (Max.)	140

i. Optimistic Approach : The maximum out off maximum payoff is 230 which is correspond to S_4. So, according to Optimistic approach, the decision maker should select strategy S_4.

ii. Pessimistic Approach: The maximum out off minimum payoff is 200 which is correspond to S_1. So, according to pessimistic approach; the decision maker, should select strategy S_1.

2064 Q. No. 10

Soln

= Given:

Cost Per Unit (CP) = Rs. 24
Sales per Unit (SP) = Rs. 31
Salvage value (SV) = 0
Demand = 33 to 36

Marginal profit (MP) = SP - CP = 31 - 24 = Rs. 7
Marginal loss (ML) = CP - SV = 24 - 0 = Rs. 24

Payoff Table (Benefit)

Strategy	State of Nature (Demand)			
	N_1 (33)	N_2 (34)	N_3 (35)	N_4 (36)
S_1 (33)	231	231	231	231
S_2 (34)	207	238	238	238
S_3 (35)	183	214	245	245
S_4 (36)	159	190	221	252

Working Note:

Payoff ($D \geq S$) = Unit sold x MP
($D = 33, S = 33$) = 33×7 = Rs. 231

Payoff ($D < S$) = Unit sold x MP - unit unsold x ML
($D = 33, S = 34$) = $33 \times 7 - 1 \times 24 = 207$

Regret Table

Strategy	State of Nature			
	$N_1(33)$	$N_2(34)$	$N_3(35)$	$N_4(36)$
$S_1(33)$	231-231 = 0	238-231 = 7	245-231 = 14	252-231 = 21
$S_2(34)$	231-207 = 24	238-238 = 0	245-238 = 7	252-238 = 14
$S_3(35)$	231-183 = 48	238-214 = 24	245-245 = 0	252-245 = 7
$S_4(36)$	231-159 = 72	238-190 = 48	245-221 = 24	252-252 = 0

2073 Old Q.No.5

Soln

=

Given:

Unit Demanded = 12, 13, 14, 15, 16, 17

Selling price per unit (SP) = Rs. 200

Cost price per unit (CP) = Rs. 140

Marginal profit (MP) = SP - CP = 200 - 140 = Rs. 60

Marginal loss (ML) = CP - SV = 140 - 0 = Rs. 140

Payoff Table

Strategy	State of Nature						Maximax	Maximin
	$D_1(12)$	$D_2(13)$	$D_3(14)$	$D_4(15)$	$D_5(16)$	$D_6(17)$	Maximum	Minimum
$S_1(12)$	720	720	720	720	720	720	720	720 (max.)
$S_2(13)$	580	780	780	780	780	780	780	580
$S_3(14)$	440	640	840	840	840	840	840	440
$S_4(15)$	300	500	700	900	900	900	900	300
$S_5(16)$	160	360	560	760	960	960	960	160
$S_6(17)$	20	220	420	620	820	1020	1020 (max.)	20

Working Note:

If $D \geq S$, Payoff = Unit sold x MP

$D=12, S=12 = 12 \times 60 = 720$

Decision:

Maximax Criteria: The maximum out off maximum payoff is 1020 which is correspond to S_6. So, according to maximax criteria, the decision maker should select strategy S_6.

Maximin Criteria: The maximum out off minimum payoff is 720 which is correspond to S_1. So, according to maximin criteria, the decision maker should select strategy S_1.

Regret Table

Strategy	State of nature						MiniMax, Maximum
	$D_1(12)$	$D_2(13)$	$D_3(14)$	$D_4(15)$	$D_5(16)$	$D_6(17)$	
$S_1(12)$	0	60	120	180	240	300	300
$S_2(13)$	140	0	60	120	180	240	240 (Min.)
$S_3(14)$	280	140	0	60	120	180	280
$S_4(15)$	420	280	140	0	60	120	420
$S_5(16)$	560	420	280	140	0	60	560
$S_6(17)$	700	560	420	280	140	0	700

Minimax Criteria: The minimum out of maximum regret is 240 which is correspond to S_2. So, according to minimax criteria, the decision maker should select strategy S_2.

2069 Q. NO. 10

Sol^n

Given:

Unit Demanded = 10, 11, 12, 13, 14

Selling price per unit (SP) = Rs. 25

Cost price per unit (CP) = Rs. 10

Salvage value (SV) = 0

Marginal profit (MP) = SP - CP = 25 - 10 = 15

Marginal loss (ML) = CP - SV = 10 - 0 = 10

Payoff Table

	Demand (state of Nature)					Maximin
Strategy	D_1 (10)	D_2 (11)	D_3 (12)	D_4 (13)	D_5 (14)	Minimum
S_1 (10)	150	150	150	150	150	150 (Max.)
S_2 (11)	140	165	165	165	165	140
S_3 (12)	130	155	180	180	180	130
S_4 (13)	120	145	170	195	195	120
S_5 (14)	110	135	160	185	210	110

Payoff = Unit sold × MP = 10 × 15 = 150 (D = 10, S = 10)

Maximin Criteria: The maximum outoff minimum payoff is 150 which is correspond to S_1. So, according to maximin criteria, the decision maker should select strategy S_1.

Regret Table

Strategy	Demand (State of Nature)					MiniMax
	D_1(10)	D_2(11)	D_3(12)	D_4(13)	D_5(14)	Maximum
S_1(10)	0	15	30	45	60	60
S_2(11)	10	0	15	30	45	45
S_3(12)	20	10	0	15	30	30 (Min.)
S_4(13)	30	20	10	0	15	30
S_5(14)	40	30	20	10	0	40

Minimax Criteria: The minimum outoff maximum regret is 30 which is correspond to strategy S_3 and S_4. So, according to minimax criteria, the decision maker should select S_3 and S_4.

2070 Q.No.5

Sol)

Given:

Unit Demanded = 45, 46, 47, 48, 49, 50

Selling price per unit (SP) = Rs. 500

Cost price per unit (CP) = Rs. 300

Salvage Value (SV) = 0

Marginal profit (MP) = SP - CP = 500 - 300 = Rs. 200

Marginal loss (ML) = CP - SV = 300 - 0 = Rs. 300

Payoff Table

Strategy	Demand (State of Nature)						Optimistic	Pessimistic
	D_1(45)	D_2(46)	D_3(47)	D_4(48)	D_5(49)	D_6(50)	Maximum	Minimum
S_1(45)	9000	9000	9000	9000	9000	9000	9000	9000 (Max.)
S_2(46)	8700	9200	9200	9200	9200	9200	9200	8700
S_3(47)	8400	8900	9400	9400	9400	9400	9400	8400
S_4(48)	8100	8600	9100	9600	9600	9600	9600	8100
S_5(49)	7800	8300	8800	9300	9800	9800	9800	7800
S_6(50)	7500	8000	8500	9000	9500	10,000	10,000 (Max.)	7500

Working Note:

Payoff = Unit sold × MP [If D ≥ S] [D=45, S=45]

= 45 × 200

= Rs. 9000

payoff = Unit sold × MP - Unit unsold × ML [If D < S]

Decision:

Optimistic Approach (Maximax) : The maximum out off maximum payoff is 10,000 which is correspond to S_6. So, according to optimistic approach, the decision maker should select strategy S_6.

Pessimistic Approach (Maximin) : The maximum out off minimum payoff is 9000 which is correspond to S_1. So, according to pessimistic approach, the decision maker should select strategy S_1.

Regret Table

Strategy	Demand (State of Nature)						MiniMax.
	D_1(45)	D_2(46)	D_3(47)	D_4(48)	D_5(49)	D_6(50)	Maximum
S_1(45)	0	200	400	600	800	1000	1000
S_2(46)	300	0	200	400	600	800	800
S_3(47)	600	300	0	200	400	600	600 (Min.)
S_4(48)	900	600	300	0	200	400	900
S_5(49)	1200	900	600	300	0	200	1200
S_6(50)	1500	1200	900	600	300	0	1500

MiniMax Criteria: The minimum out off maximum regret is 600 which is correspond to S_3. So, according to minimax criteria, the decision maker should select strategy S_3.

2065 Q. No. 10

Soln

Given:

Cost price (CP) = Rs. 3

Selling price (SP) = Rs. 4

Salvage value (SV) = Rs. 1

Marginal profit (MP) = SP - CP = 4 - 3 = Rs. 1

Marginal Loss (ML) = CP - SV = 3 - 1 = Rs. 2

Unit Demanded = 45, 46, 47, 48, 49, 50

"Complete yourself"

* Analytical Answer Question

2076 Q.No.17 / 2072 Q.No.17

Sol^n

Given:

Cost price per unit (CP) = Rs.30
Selling price per unit (SP) = Rs.50
Salvage value (SV) = Rs.0
Marginal Profit (MP) = SP - CP = 50 - 30 = Rs.20
Marginal Loss (ML) = CP - SV = 30 - 0 = Rs.30

a. Payoff Table

Probability / Demand / Stock	0.10 D_1(10)	0.15 D_2(11)	0.20 D_3(12)	0.25 D_4(13)	0.30 D_5(14)	Expected Monetary Value (EMV)
S_1(10)	200	200	200	200	200	200
S_2(11)	170	220	220	220	220	215
S_3(12)	140	190	240	240	240	222.5 (Max.)
S_4(13)	110	160	210	260	260	220
S_5(14)	80	130	180	230	280	205

Working Note:

Payoff = Unit sold × MP (If D ≥ S) [D_1 = 10, S_1 = 10]
= 10 × 20 = Rs.200

Payoff = Unit sold × MP − Unit unsold × ML (If D < S) [D_1 = 10, S_2 = 11]
= 10 × 20 − 1 × 30 = Rs.170 and so on...

b. Calculation of Expected Monetary Value (EMV)

EMV = Σ Probability × pay-off

For $S_1 = 10$:

EMV = 0.10 X 200 + 0.15X200 + 0.20X200 + 0.25X200 + 0.30X200 = 200

For $S_2 = 11$:

EMV = 0.10X170 + 0.15X220 + 0.20X220 + 0.25X220 + 0.30X220 = 215

For $S_3 = 12$:

EMV = 0.10X140 + 0.15X190 + 0.20X240 + 0.25X240 + 0.30X240 = 222.5

For $S_4 = 13$:

EMV = 0.10X110 + 0.15X160 + 0.20X210 + 0.25X260 + 0.30X260 = 220

For $S_5 = 14$:

EMV = 0.10X80 + 0.15X130 + 0.20X180 + 0.25X230 + 0.30X280 = 205

c. Since, the maximum EMV is 222.5 which is correspond to S_3, so, the profit can be maximized at quantity 12.

d. Cal^n of Expected profit with perfect Information (EPPI)

EPPI = Σ Probability X Diagonal pay-off

= 0.10X200 + 0.15X220 + 0.20X240 + 0.25X260 + 0.30X280

= 250

e. Cal^n of Expected value of Perfect Information (EVPI)

EVPI = EPPI − Max. EMV

= 250 − 222.5

= 27.5