7

Optimal Size of Stock Under Stochastic Situation

A trader is always confronted with the problem of ascertaining the correct size of inventory which is affected by complex set of factors, e. g., liking of a customer for the commodity, availability of a substitute, the price and the nature of the commodity, the goodwill loss on non-supply of goods in time, etc. Under the variable circumstances, although absolute correct answers are difficult to find, an attempt at keeping inventory at justifiable level, so that 'more than reasonable' deviation on either side from the near-ideal size may not be permitted, will save the trader from heavy losses. In a situation of understocking the trader suffers a loss—commonly known as 'opportunity loss'—due to his inability to meet the required demand of his customers; and in a case of overstocking he suffers a loss composed of—loss of interest on capital locked up in excessive stock ; a loss due to cost of extra supervision of storing facility ; a loss due to obsolescence, wastage and spoilage. An optimal size of stock, therefore, is an essential requirement for maximising the profits of the concern. Hence, in this paper, an attempt has been made to determine such an optimal size of inventory of a given commodity which a trader should keep for the known probabilities of a set of events based on his past experience. This has been done by taking an example of a commodity of a fast perishing nature with the help of "Expected Monetary Value" technique. However, to avoid complications, following assumptions have been made :—

(a) Although the trader works under uncertainty as to the demand for his product by his customers, there are no jolty fluctuations in events. They fluctuate within limited range.

(b) The supply of goods to the trader is assumed to be infinite.

(c) Events taking place are presumed to be discrete in nature, i. e., either there are three events or four events but not between three and four.

(d) The trader is not likely to incur any potential utility loss, or, in other words, utility function varies in linear relation with monetary function.

(e) The unsatisfied demand does not bring him any "goodwill loss".

(f) The commodity can, since it is of fast perishing nature, last with its proper values only for a predetermined period after which the salvage value of the commodity is assumed to remain at 1/5th of the actual value of the stock. This is more suited in Indian conditions, because shortage of supply of goods on the one hand and poverty on the other hand, make even substandard goods acceptable to many persons in this country.

Example

Although intuition and subjective approach play an important role in the decision making in uncertain conditions, an element of error, so natural with such an approach, may, to a great extent, be reduced by basing the decision on the probabilities of the occurrence of events experienced by the trader in the past. In order to illustrate, the historic probabilities of the demand of certain number of units of a product of a trader over a period of 300 days have been arranged in the form of a table as under :—

TABLE I
FREQUENCY OF DEMAND

Demand in Units per day	*No. of Days (frequency)*	*Cumulative frequency*
70	60	60
80	120	180
90	75	255
100	45	300

He also informs that the cost price of per unit of product is Rs. 15 and sales price is Rs. 20. Thus he makes a profit of Rs. 5 per unit in case of sale and loses Rs. 12 per unit in case of unsold stock (salvage value of unsold stock being 1/5th of cost price).

Conditional profits

Statistics supplied by the trader clearly indicate that there is almost no possibility of demand of less than 70 units and more than 100 units per

day and hence in no circumstances he should keep the stock of less than 70 units and more than 100 units. But the trader is not certain about the demand of stock on the next day, which may fluctuate from 70 units to 100 units and, therefore, if the trader decides to keep the stock of 70 units and there happens to be the demand of more than 70 units, he loses opportunity profits on the demand of more than 70 units. On the other hand, if he decides to keep the stock of 80 or 90 or 100 units he increases the probabilities of losing profit because of sharp fall in the value of unsold stock in case the demand is less than the stock held. In order to have an idea of profits which the trader makes under each probability, following table has been framed :—

TABLE II

TABLE SHOWING CONDITIONAL PROFITS UNDER EACH PROBABILITY

Demand (events in Units)	*Decision regarding Stock*			
	70 Units	*80 Units*	*90 Units*	*100 Units*
70	350 (—)	230 ⟨ 120 ⟩	110 ⟨ 240 ⟩	-10* ⟨ 360 ⟩
80	350 (50)	400 (—)	280 ⟨ 120 ⟩	160 ⟨ 240 ⟩
90	350 (100)	400 (50)	450 (—)	330 ⟨ 120 ⟩
100	350 (150)	400 (100)	450 (50)	500 (—)

Figure marked (*) shows loss.
Figure in ( ) shows opportunity loss.
Figure in ⟨ ⟩ shows loss due to fall in value.

Optimal Profits under certainty

From the above Table it is possible to prepare a table showing the optimum profits in each "act" i. e., "act 70" to "act 100" units of stock.

TABLE III

TABLE SHOWING OPTIMAL PROFITS

Events	*Acts*			
	70 Units	*80 Units*	*90 Units*	*100 Units*
70	350	—	—	—
80	—	400	—	—
90	—	—	450	—
100	—	—	—	500

This is very clear from the above table that the maximum profit for each act of the trader happens to be only when his acts are equal to events.

Since event is an independent variable, therefore, the trader has to make effort in adjusting the act according to the event.

Expected Monetary Value (EMV)

Though conditional values of acts, as per above table, can help the trader in determining the maximum profits by adjusting the act according to the event but that he could do only when he knows in advance the demand of the next day. Since he, as most of the traders, works under uncertainty as to the demand for the next day, the only possible way of foreseeing the demand is to take the help of probabilities with which demands recurred in the past. The probabilities of demand of the past event have been reduced in "Zero to one" table as follows :—

TABLE IV

Events	*Number of Days*	*Probability*
		300=1
70	60	·20
80	120	·40
90	75	·25
100	45	·15
Total	300	1·00

From the above table, a conclusion can be drawn that "event 70" is likely to recur only for 60 days out of 300 days, i. e., ·20 times of 300 days and, similarly, "event 80" for ·40 times and so on. Therefore, these probabilities can be taken as guidance for the future. Therefore, "event-70", "event-80", "event-90", and "event-100" is likely to recur only ·20, ·40, ·25, and ·15 times in the future, whether the trader keeps the stock of 70 units or 80 units or 90 units or 100 units. With the help of these probabilities of events, the profit for each act has been calculated as undertermed as expected monetary profits, or expected monetary values :—

TABLE V

TABLE SHOWING EXPECTED MONETARY VALUES

Event	*Proba bility*	*Act 'stock-70'*		*Act 'stock-80'*		*Act stock-90'*		*Act'Stock-100'*	
		C.V.	EMV	C.V.	EMV	C.V.	EMV	C.V.	EMV
		Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
70	·20	350	70·00	230	46·00	110	22·00	(—10)	—2·00
80	·40	350	40·00	400	160·00	280	112·00	160	64·00
90	·25	350	87·50	400	100·00	450	112·50	330	82·50
100	·15	350	52·50	400	60·00	450	67·50	500	75·00
	1·00		350·00		366·00		314·00		219·50

CV = Conditional Values
EMV = Expected Monetary Values
= (CV) X (Probability)

Since the sum of EMV in act "Stock 80" is the highest, i. e., Rs. 366, it is wortwhile for him to keep a float of 80 units irrespective of the fact there is a probability of event fluctuating from 70 Units to 100 Units.

Should trader try to collect more information ?

There could be a genuine anxiety troubling the trader, that should he try to collect more information about the trend of demand in the market. Because, the more informed he is about the future demand, the better step he can choose for the purchase of stock, and the more profit he can make by avoiding opportunity loss or loss due to fall in value of unsold stock. But any effort for the collection of extra information does need extra cost and the trader should know in advance as to what extent should he go on spending because spending money without limit will start bringing him loss instead of profit. The maximum amount of money, which he can spend in collecting extra information to become more exact, can be easily determined by comparing EMV under certainty and EMV under uncertainty. The difference between the two, will be the 'cost of perfect information', (abbreviated as CPI). The trader must not spend beyond the value of CPI, rather he should try to spend as less as possible. Following tables have been used for calculating CPI.

TABLE VI

TABLE SHOWING EMV UNDER CERTAINTY

Event	*Proba-bility*	*C V under certainty*	*E M V under certainty* 3×2
1	2	3	4
70	·20	350	70·00
80	·40	400	160·00
90	·25	450	112·50
100	·15	500	75·00
	1·00		417·50

TABLE VII

TABLE SHOWING CPI*

	Events			
	70	*80*	*90*	*100*
EMV under ecrtainty *(See Table VI)*	417·50	417·50	417·50	417·50
EMV under uncertainty *(See Table V)*	350·00	366·00	314·00	219·50
Loss due to uncertainty	67·50	51·50	103·50	198·00

*CPI=EMV under certainty less EMV under certainty

As per the above table the loss of profits to the trader ranges from Rs. 51·50 to Rs. 198·00 but in fact the maximum loss of Rs. 198 under Act "100-Units" can be easily reduced to Rs. 51·50 only on the basis of past experience and for this no extra information is needed. However the maximum profit of Rs. 366·00 under uncertainty cannot be raised to the maximum profit of Rs. 417·50 without further knowledge of occurences of events. Thus the magnitude of the extra profit is the yardstick for measuring the cost of perfect information, which in this case is Rs. 51.50 and the trader must not spend more than this amount.

Thus, it may be concluded from the above simple model that a trader can always make his decision more rational and minimise his losses. However, there is fairly a good scope for designing a more sophisticated model by adding a few new variables.

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