COMMENTS ON 'THE SAFETY STOCK SYNDROME'

My first professional experience in the inventory management area was as a colleague of Bob Brown at Arthur D. Little Inc. in the mid-1960's. Thus, I read with particular interest Snyder's article\(^1\) in which, for a fixed order quantity-reorder point inventory control system, he contrasts two service measures that Brown has discussed in earlier literature.\(^2,3,4\)

Snyder argues that the probability (which we denote by \(p_1\)) of a shortage at a random point in time is a more appropriate service measure than the probability (which we denote by \(p_2\)) of a shortage just before the delivery of a supplier replenishment (i.e. just before the end of a replenishment lead time). Furthermore, he points out that even for fairly low values of \(p_1\) (i.e. very high service levels) an appropriate model suggests the use of a negative safety stock. The latter, in turn, implies that the stock manager is deliberately planning to be in a shortage situation at the end of more than 50% of the replenishment lead times. Regardless of the 'desirability' of using the \(p_1\) measure, such a situation may, quite rationally, be viewed as intolerable by the manager. This dilemma simply points out the difficulty of establishing an appropriate measure of service and an appropriate level, given the measure. The choice of a level of safety stock represents the expression of a manager's attitude towards the conflicting risks of having too much stock on hand versus running short. As discussed further in Peterson and Silver,\(^5\) there is no single way to prescribe this balancing of risks. The choice of measure and level should depend upon the risk-taking attitude of the manager involved, which, in turn, depends upon such factors as his sense of security, the competitive environment of the company, etc.

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REPLY

In a recent paper\(^1\) I argued that safety stocks are not always necessary to ensure high levels of service from fixed order quantity-reorder point inventory systems. To highlight the point, an extreme but quite plausible example involving a zero reorder point was used to demonstrate the possibility of a high level of service despite a 100 per cent probability of being short at the time of replenishment deliveries. Because orders were large and placed infrequently while the delivery lead time was relatively short, the proportion of time spent out of stock was still quite small. The aim of the example was to discourage people from using the probability of a shortage at a delivery as the criterion for selecting the reorder point and to replace it with the more reliable measure of dis-service, namely the probability of a shortage at a random point of time.

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Edward Silver has now commented on my paper, suggesting that there is still room for the probability of a shortage at a delivery if it is the way managers prefer to express their attitude towards risk. Certainly, if managers cannot be convinced otherwise, a consultant would be obliged to employ this criterion. But this does not mean that it is good business practice. If we view the overall objective of the business to be one of long run profit maximization, then the use of this approach could lead to a form of suboptimization.

To make this point clearer, it is widely accepted that order quantities and reorder points effect profit through three kinds of costs, namely acquisition, holding and backlog costs. Thus to maximize long run profit, it is necessary to minimize the expected value of these inventory costs. Lampkin and Flowerdew\(^6\) have shown that the latter occurs when the order quantity \(Q\) and the reorder point \(R\) are selected using the following optimality conditions

\[
Q = \sqrt{2K\mu/h + 0(Q,R)} \tag{1}
\]

and

\[
Pr\{\text{SHORTAGE AT RANDOM TIME}\} = h/(h+p), \tag{2}
\]

where \(K\) is the acquisition cost; \(\mu\) is the mean demand; \(h\) is the unit holding cost; \(0(Q,R)\) denotes a function which is small enough relative to \(Q\) to be ignored; and \(p\) is the unit backlog cost. Ideally these conditions should be used when determining inventory parameters in the backlog situation. However, in practice they are hard to apply to the extent that the unit backlog cost \(p\) is usually difficult to measure. This problem would normally be circumvented by replacing the right hand side of (2) with an acceptable target shortage probability specified by management. The conditions would then become operational for business purposes.

Returning to the theme of this reply, it is important to note that the conditions for long run profit maximization entail the probability of a shortage at a random time rather than a delivery. Of course, not all economic models need be the same as the one presented by Lampkin and Flowerdew.\(^6\) But I know of no economic model of a fixed order quantity-reorder point system which possesses optimality conditions involving the latter. The use of the probability of a shortage at a delivery as the criterion for choice could therefore only lead to a form of suboptimization. Profits would suffer, and if economic theory about the process of competition in open markets is to be believed, the long run existence of business concerned would be jeopardized.

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