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Minimizing the Expected Total Value of Shortages for a Population of Items Subject to Practical Restrictions on the Reorder Points

Ilkyeong Moon
Department of Industrial Engineering, Pusan National University, KOREA
Edward A. Silver
Faculty of Management, The University of Calgary, CANADA

Abstract

Managers are concerned with the effective use of limited resources. An example is the allocation of a specific budget among the safety stocks of a population of items, each of which is controlled by a continuous review, order point, order quantity system. One possible criterion is the minimization of an aggregate measure of disservice, such as the expected total value of units short per year (ETVSPY). The case where there is no restriction, other than the budget constraint, on the choice of safety stocks (or reorder points) has been treated in the literature. In fact, by varying the levels of the available budget, one can trace out a whole exchange curve which shows the best that one can do on the service measure as the budget is varied. However, these results hinge upon continuous possible values of the decision variables (the reorder points or, equivalently, the safety stocks); but, in practice, managers often prefer to restrict the decision variables to a set of easily understood and implementable discrete values, e.g. the reorder point, expressed as a time supply, which is restricted to one of the following values: 1 week, 2 weeks, 1 month, 2 months, 3 months, 6 months or 1 year.

This paper addresses how to deal with the above constrained problem in a pragmatic fashion. Specifically we treat the case where there is a set of time supplies, one of which must be used for each of a population of items. There is a specified upper limit on the total value of safety stock to

be used and we wish to choose the time supply reorder points of the population of items, subject to the discrete set of options and the aggregate constraint, so as to minimize the expected total values of the units short per year.

In the next section we introduce the notation and mathematically formulate the problem, including obtaining a useful lower bound. This is followed by the specification of an optimal solution procedure using a branch and bound algorithm. The associated computational effort required increases substantially with the number of items. Perhaps more important, branch and bound is a very difficult concept to explain to practitioners. Therefore, we subsequently present a heuristic approach that overcomes both of these drawbacks. Moreover, we present results of computational experiments that show that very little degradation in the objective function value results from using the heuristic instead of the optimal solution. However, the performance of the optimal solution is markedly affected by the discrete choice of the time supplies, particularly if the set is fairly sparse as would likely be the case in practice.

Keywords: inventory, safety stock, lower bound, branch and bound, heuristic

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Correspondence: Dr. I. Moon, Department of Industrial Engineering, Pusan National University, Pusan 609-735, KOREA

Email: ikmoon@hyowon.pusan.ac.kr   Tel: +82-51-510-2451   Fax: +82-51-512-7603