Chapter 14
Risk–Averse Newsboy Problem with Incomplete Demand Information:
Risk–Averse Newsboy Problem

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ABSTRACT

In the traditional inventory management literature, it is a quite common assumption that the probability distribution of stochastic demand is completely known to the decision maker. However, in reality, there are ample evidences where the demand distribution is not known with certainty. In order to cope with the practical situation, it is, therefore, necessary to investigate inventory models with available incomplete information. This chapter is aimed to study a simple single-period newsboy problem in which the decision maker is risk-averse and the demand information is not perfectly known to him/her. We derive a forecast cost for the period based on sample observation used to set the value of an unknown parameter of the distribution. We analyze the significance of risk aversion on the optimal decisions. From numerical study, we observe that the expected forecast cost increases when less information about demand is available and that the risk-averse inventory manager incurs higher cost than risk-neutral manager.

1. INTRODUCTION

Inventory refers to physical goods or materials that are hold by business organizations for the purpose of future affairs. It is also defined as an idle resource of an enterprise. The term 'inventory' is generally used to indicate raw materials, work in process (WIP) and finished goods which are stocked in order to meet their expected demands. There are many reasons for carrying inventories such as smooth and efficient running of business, adequate service to customers, cash flow improvement by timely shipment of customer order, absorbing fluctuations in demand, taking advantage of price discount and so on. There are also some apprehensions of holding inventory such as locking up of capital, maintenance costs due

to storage, personnel, insurance, obsolescence, etc. Thus excess inventory is economically undesirable which leads to development of inventory control theory, the basis of which is to determine – how much to order and when to order so that the total inventory cost is minimized. When demand is assumed to be fixed and completely pre-determined, inventory problems are usually referred to as *Economic Order Quantity* (EOQ) or *Lot Size* problems. Since the invent of Harris's (1913a, 1913b) square root formula for EOQ, numerous studies have been conducted by researchers all over the world aiming at fitting mathematical models into real world inventory systems. However, in majority of occasions, derived theoretical results do not appropriately match in practice; the optimal policy performs far away from the predicted target. One of the key reasons is that while developing these models, all the relevant information (e.g. demand distribution and all the associated parameters) are assumed to be known with certainty by the decision maker. In true sense, this is however not the case in general. For instance, consider the newly launched products or slow moving products. Sufficient historical data may not be available for defining functional forms of demand distribution functions of these products. When demand is uncertain, probability distribution of demand is an important input in inventory management. Replenishment strategy or inventory control parameters cannot be correct unless special attention has been paid to deal with the event of incomplete or partial demand information (where some characteristics of the demand process are not known with certainty).

In the inventory literature, the issue of incomplete demand information has been addressed by several researchers. Scarf (1958, 2002) offered the mini-max order formula for a *newsboy problem* which is also known as newsvendor or single-period inventory problem characterized by fixed prices and uncertain demand for a perishable product. The problem is so called due to analogy with the situation faced by a newspaper vendor who must decide how many newspapers to buy from his supplier in the face of uncertain demand; if he buys too many newspapers, he will be left with unsold copies that have no value at the end of the day; on the other hand, if he buys fewer papers, he may miss the opportunity of making higher profit. Scarf's idea was to consider only the mean and variance of demand instead of the whole distribution of demand and to find the order quantity that maximizes the worst-case expected profit. Gallego and Moon (1993) provided a review and extensions of distribution-free newsboy problem. Perakis and Roels (2008) adopted minimax regret approach when partial demand information such as mean, variance or unimodality, etc. is known. Jacobs and Wagner (1989) investigated how the choices of estimators affect the mean total cost. They showed that when demand variability is large, exponentially smoothed estimators can substantially outperform the sample mean and sample variance. The problem of incomplete knowledge about the distribution of the demand is handled by Bookbinder and Lordahl (1989) and Fricker and Goodhart (2000) using Bootstrap method. Vairaktarakis (2000) used a performance criterion in order to minimize the maximum regret using only upper and lower bounds of demand that are known. Kamath et al. (2002) studied the bayesian approach to a dynamic inventory model under an unknown demand distribution. Bensoussan et al. (2007) studied a multi-period newsvendor problem with partially observed demand. They assumed that the demand distribution in each time period is determined by a Markov chain. Ramaekers and Janssens (2012) determined upper and lower bounds for two performance measures: the number of stock-out units and the stock-out probability per replenishment cycle when only two moments of the demand distribution are known. Based on these results, they derived the optimal inventory level given the desired maximum number of stock-out units or the desired maximum

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