

## Chapter 22

# Optimal Pricing Strategies for an Inventory System with Perishable Items and Waiting Time Dependent Order Cancellations

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### ABSTRACT

*Although many researchers have studied inventory models for perishable items, the situation of advance sales, spot sales and order cancellations have not been addressed so far. However, this problem arises in a variety of industries including the sales of fashion garments, flight seats and hotel rooms. In this article, we deal with an inventory system in which sales cycle is divided into an advance sales period and a spot sales period. We consider order cancellation effect which depends on the waiting time of the customer orders. The goal is to determine the optimal order quantity and optimal prices in order to maximize the profit. We also show the concavity of the profit function using mathematical lemmas and theorem. Besides we develop a solution procedure which computes optimal policy effectively. Finally we present the results of numerical study for linear and exponential demand functions.*

### INTRODUCTION

In many industrial settings, managers face the problem of establishing a pricing policy that maximizes the revenue from selling a given inventory of items by a fixed deadline, with the full

inventory of items being available for sale from the beginning of the selling period. The items unsold by the deadline have a constant salvage value, which we assume to be zero for simplicity. Pricing must be based on cost to create profit; meanwhile, the price of a product should not be too high to dissuade consumers from purchasing.

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Therefore, producers have to treat product pricing as a competitive tool in their marketing strategy.

This article considers the inventory problem of ordering and pricing for perishable items over a finite time planning horizon with advance sales and spot sales. Examples of industries where the considered problem arises fall broadly into two categories: those where the product is a manufactured good with a limited shelf life (such as food items or fashion garments), and those where the product is a service (such as flight seats or hotel rooms). Mostly the advance sales customers are expected to purchase a product at a price lower than the spot sales price. Therefore, it seems to be attractive to give price discounts and in turn the firms can improve their profits to a certain extent. Since a poor price setting may result in losses, how to set the spot sales price and the advance sales price has become important decision making problem.

Advance sales system for perishable items can be easily seen in the market. Examples include the fruit items, food items, blood packets, etc. During the advance sales, the firms allow purchase discounts to attract customers with lower valuations in order to improve their profits. Engaging in advance sales has great potential to yield higher profits for many industries. The reasons for firms to offer advance purchase discounts are partially derived from the effects of exploiting economies of scale and revenues. For example, it is a business practice that consumers with relatively lower valuations have incentives to make advance purchase because consumers with higher valuations may increase the price since they are willing to pay in the spot market. This scenario leads to a situation whereby firms use advance purchase discount policies to attract customers with lower valuations in order to improve their profits. Offering discount prices during the advance sales period can improve the overall sales revenues as compared to the model using only a spot sales price.

When adopting the system with advance sales, organizations may face some problems. In

many real systems, some customers do not wish or can not wait for the next order to satisfy their demands. It involves the cancellation of orders. It is not unusual for customers to withdraw their advance purchase orders during the advance sales period. Ignoring this phenomenon may lead to the situation of over estimating the demand and reduced profits due to higher inventory purchasing and holding costs. To avoid such a situation, it is worthwhile to consider the phenomenon of order cancellations when making inventory decisions. The fraction of customers who are not willing to wait is proportional to the ratio between the waiting time and the length of the order arrivals. This assumption is equivalent to admit that the probability customers who are willing to wait is linearly decreasing with respect to the above ratio. So the collective behavior of customers hinges on the waiting time. It is expected that the customers cancel their orders if their waiting time is large enough. In other words, the order cancellations depend on the waiting time of the customers during advance sales period. Indeed the proportion of order cancellation is inversely proportional to the waiting time.

Considering the above situations, this article addresses the simultaneous determination of ordering policy, advance sales price and spot sales price. The decision maker is assumed to be able to shift the demand rate by means of pricing policy. The purpose of this article is to find the optimal decision for maximizing the total profit over a finite time planning horizon. The decision rules include (1) the order size, which is placed at the start of every cycle; (2) the advance sales price which is set during advance sales periods and (3) the spot sales price, which is set during the spot sales periods.

## **LITERATURE REVIEW**

The analysis of deteriorating inventory began with Ghare and Schrader (1963), who established

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