

## Optimal replenishment schedule and pricing policy for hybrid retailers with continuously decaying demand in time and price

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### Abstract

This study deals with the problem of jointly predetermining optimal replenishment schedule and selling prices toward hybrid retailers who sell products via in-stores and e-stores concurrently, where deteriorating item is considered with two declining demands in time and price. Under the circumstances, strict concavity of the proposed problem in selling prices is first proven, and closed-form solutions for selling prices are thereby obtained. Next, when selling prices are fixed, not only the strict pseudo-concavity in replenishment interval is shown, but also the optimal schedule uniquely exists if the criterion inequality holds, which is also a premise for positive profit generation. Afterwards, three solution-finding sequences are defined, to which the convergent property is identified, by which a simple

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algorithm for optimal solutions is presented. Finally, numerical examples are conducted to illustrate the proposed problems.

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## 1. Introduction

Nowadays, e-tailing has been receiving growing attention in the field of inventory management because more and more shopping transactions are completed via e-channels, which could be the Internet, television or catalogue. According to the findings in Farag *et. al.*, [4], some people would rather shop through e-channels for time-saving purposes, while others prefer in-store shopping with leisure orientation. Empirically, many individuals tend to browse product information online ahead of proceeding their in-store shopping, whereas some will search products online first, then check them out personally in-store and finally purchase through e-shopping.

Of particular advantage of e-tailing is the unlimited area of virtual stores which traditional stores fail to reach, especially in rural and remote regions. In addition, based on Zhao and Cao[13], e-tailers benefit from the so-called zero-inventory policy, by which they carry no inventories and will order products from suppliers and ask for direct delivery to consumers when receiving orders, so the holding cost is dispensable, accordingly. As a result, multi-channel retailing is now being thought of as more competitive. Examples of such related retailers in Taiwan include RT-mart, Uni-mall and Momo-shop, which possess their own outlets and meanwhile provide e-channel platforms to customers.

In contrast, the traditional economic order quantity (EOQ) makes an effort to manage optimality problems on order quantity, selling price, multiple discounts, selling period and replenishment schedule by means of either minimizing total cost (per unit time) or maximizing total profit (per unit time), Khouja [7] solved the newsboy problem with multiple discounts in which the objectives of maximizing expected profit and the probability of achieving a target profit are separately investigated. Later, Khouja [8] himself extended the problem to the case where demand is price-dependent and multiple discounts with prices under control to sell excess inventory are offered. In addition, Urban