Dynamic pricing and advertising of perishable products with inventory holding costs

Rainer Schlosser
Hasso Plattner Institute, University of Potsdam, Germany

1. Introduction

In a variety of practical applications, revenue management models are used for the sale of perishable products. Examples of such models can be found in a variety of contexts, for instance, fashion markets, fruit markets, ticket sales of special events, or transportation services. Managers dynamically set prices in order to maximize expected profits. Often sales costs (e.g., shipping costs) as well as inventory holding costs have to be taken into account (e.g., storage costs). Moreover, in some applications, advertising is also used to attract more customers. In this case, the seller is required to choose appropriate pricing and advertising decisions simultaneously. For this reason, a dynamic pricing model with a finite time horizon and endogenized advertising effects is needed in which the difference of expected revenues and expected expenditures is maximized.

In this paper, we consider a time-dependent stochastic dynamic pricing and advertising model for the sale of a stock of perishable products including marginal unit costs and inventory holding costs. Unfortunately, closed form solutions of such models barely exist. Hence, powerful heuristics as well as explicit special case solutions are very useful. Our aim is (i) to derive optimal policies, (ii) to evaluate optimal controlled sales processes, and (iii) to identify heuristics that are nearly optimal.

The best way to sell perishable products is a classical application of revenue management theory. The problem is closely related to the field of dynamic pricing which is summarized in the books by Talluri and van Ryzin (2004) and Phillips (2005).

E-mail address: rainer.schlosser@hpi.de

http://dx.doi.org/10.1016/j.jedc.2015.05.017
0165-1889/ © 2015 Elsevier B.V. All rights reserved.
The main contributions of this paper are (i) a time-dependent dynamic pricing and advertising model with inventory holding costs. The arrival rate of potential customers and the unit costs may also depend on time. In Section 2.2 we derive the solution of the model and give explicit formulas for the value function as well as the optimal feedback controls. In order to evaluate the optimal policy, we derive formulas for state probabilities of the optimally controlled inventory process and illustrate examples. In Section 2.3, we prove the convergence of the value function for small shares to a two-part limit function.

In Section 3, we consider the deterministic version of the model with continuous state space. It is revealed that the limit function determined in Section 2.3 coincides with the solution of the Hamilton–Jacobi–Bellman (HJB) equation, which is associated with the deterministic control problem. The corresponding solution in feedback form is presented in Section 3.2. In Section 3.3, we determine the optimal inventory path and evaluate the optimally controlled sales process as a function of time, cf. open-loop form. Moreover, the results are compared to its stochastic counterparts. To identify characteristic properties of the complex interplay between various model parameters, sensitivity results are presented. Finally, in Section 4, we verify the excellent performance of heuristics that are based on the feedback solution of the deterministic model applied in a stochastic environment. We determine the expected profits of these suboptimal policies by solving the associated difference–differential equations explicitly. In Section 5, we summarize our results and give management recommendations. The proofs of our results are relegated to the Appendix.

2. Analytical solution of the stochastic model

2.1. Model description

We consider the situation where a monopolist wants to sell \( N \) items, \( N < \infty \), of a perishable product over a finite time horizon \( T \). We extend the time-homogeneous model by MacDonald and Rasmussen (2010) to a fairly general time inhomogeneous one including time-dependent unit costs and holding costs.
دریافت فوری
متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات