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Abstract

This paper examines the sale of a finite number of items in a class of stochastic dynamic pricing and advertising models with time-dependent demand elasticities. We prove structural properties of the optimal expected profits with respect to time, inventory level, price impact, advertising impact and different model parameters, such as discount rate, marginal unit costs, and holding costs. We find that the value of an additional item (opportunity costs) is decreasing in the unit costs, the discount rate, the holding cost rate and the number of items left to sell. We also derive structural properties of optimal joint pricing and advertising strategies. This way, we obtain general qualitative insights in the complex interplay and the mutual dependence of optimal pricing and advertising decisions. Among other properties, we show that a higher advertising impact leads to higher optimal prices and lower advertising rates, which in turn implies a lower speed of sale. The results obtained help practitioners to respond to changes in market conditions by adjusting price and advertising accordingly. Our results allow speeding up numerical computations of decisions as the set of possible actions can be reduced significantly. Our analysis implies general results for pure pricing as well as pure advertising models with time-dependent demand elasticities.

Keywords:
dynamic pricing and advertising, optimal stochastic control, time-dependent demand elasticities, structural properties

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1. Introduction

1.1. Motivation

Revenue management optimization models become increasingly important for example in the e-commerce framework. Setting prices and determining the level of advertising expenditures are two key marketing mix variables. Hence, in many businesses, sellers are required to choose appropriate pricing and advertising decisions simultaneously. To examine the complex interplay of marketing mix strategies, a general demand model that incorporates dynamic pricing and endogenized advertising effects is needed. The objective of such a model should maximize the difference between the expected revenue and expected advertising expenditure. By deriving structural properties of such models, it can be determined how the interactions of joint optimal pricing and advertising strategies are affected by different influencing factors (e.g., cost and

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