Online Auction and List Price Revenue Management

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We analyze a revenue management problem in which a seller facing a Poisson arrival stream of consumers operates an online multiunit auction. Consumers can get the product from an alternative list price channel. We consider two variants of this problem: In the first variant, the list price is an external channel run by another firm. In the second one, the seller manages both the auction and the list price channels.

Each consumer, trying to maximize his own surplus, must decide either to buy at the posted price and get the item at no risk, or to join the auction and wait until its end, when the winners are revealed and the auction price is disclosed.

Our approach consists of two parts. First, we study structural properties of the problem, and show that the equilibrium strategy for both versions of this game is of the threshold type, meaning that a consumer will join the auction only if his arrival time is above a function of his own valuation. This consumer’s strategy can be computed using an iterative algorithm in a function space, provably convergent under some conditions. Unfortunately, this procedure is computationally intensive.

Second, and to overcome this limitation, we formulate an asymptotic version of the problem, in which the demand rate and the initial number of units grow proportionally large. We obtain a simple closed-form expression for the equilibrium strategy in this regime, which is then used as an approximate solution to the original problem. Numerical computations show that this heuristic is very accurate. The asymptotic solution culminates in simple and precise recipes of how bidders should behave, as well as how the seller should structure the auction, and price the product in the dual-channel case.

Key words: revenue management; online auction; dual channel; strategic behavior; asymptotic analysis

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1. Introduction

In the last few years, Revenue Management (RM) has widened its focus from capacity control and dynamic pricing to alternative selling mechanisms proposed by electronic commerce, such as group purchasing, online negotiations, and auctions. (See Talluri and van Ryzin 2004 for a reference on RM methods and applications, or the survey by Bitran and Caldentey 2003 for an overview of dynamic pricing models.) Although list pricing is probably still the most familiar and used pricing mechanism, online auctions are certainly an increasing phenomenon.

Nowadays, a huge variety of products is sold simultaneously through online posted price and auction channels, allowing consumers to compare prices and bid states easily across different channels in real time. This boost in market information and the corresponding reduction in search costs have a significant impact on consumers’ purchasing behavior and should be considered by a seller when designing online sales mechanisms.

In this paper, we address the problem of an online seller who is endowed with a fixed initial inventory and faces a stochastic arriving stream of strategic consumers. To capture different e-business environments, we consider two alternative formulations. First, we consider the case in which the seller controls an online auction exclusively and competes with a third party that manages a list price channel. We refer to this case as the single-auction channel model. In the second formulation, the dual-channel model, the seller is a monopolist and controls both the auction and list price channels.

For these two scenarios, we are interested in answering the following questions: How should strategic consumers behave, that is, which channel should each consumer choose? What should the bidding strategy be of those consumers that enter the auction? Given consumers’ behavior, how should the seller manage an online auction to maximize revenue? What should the length of the auction and the reservation price (i.e., minimum acceptable bid) be? How should the seller manage parallel online auction and list price channels to maximize revenue? In particular, the dual-channel case motivates an important managerial question: How should the seller design both channels to segment the population of consumers to extract as much revenue as possible from each