INVENTORY MANAGEMENT IN A (Q, r) INVENTORY MODEL WITH TWO DEMAND CLASSES AND FLEXIBLE DELIVERY

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ABSTRACT. *This paper considers a single-product inventory system that serves both on-line and traditional customers. Demands from both channels follow independent stationary Poisson processes. Traditional customers have their demands fulfilled upon arrival if the retailer has stock on hand; otherwise the demand is lost. However, online customers place their orders in advance, and delivery is flexible in the sense that early shipment is allowed. In particular, an online order placed at time t should be fulfilled by time $t + T$, where T is the customer's demand lead time [1]; late fulfillment incurs a time-dependent backorder cost. A (Q, r) replenishment policy is used and replenishment lead times are assumed to be constant. We develop an approximation for the expected annual cost for the retailer, and compare analytically and simulated results. The optimal parameters of the system are derived by minimizing the expected annual cost. We illustrate the model with numerical examples, and discuss the sensitivity of the results to variables such as demand lead time and the split between online and traditional orders.*
Keywords: Inventory model, Multi-channel, Demand lead time

1. **Introduction.** The Internet has become an important retail channel in the past decade. In 2004, online sales comprised about 5.5% of all retail sales excluding travel [2]. In most product categories, a bricks-and-clicks structure, where one company has both the Internet and a traditional presence, is becoming the dominant form of the Internet participation. Large, traditional retailers such as Wal-Mart, Staples and Best Buy have websites that sell their products in significant volumes [3]. Meanwhile, some traditional online-only companies are expanding their business to retail stores. For example, Dell has installed kiosks in shopping malls and sells its computers through Costco [4]. Such firms now have two different channels to reach their customers, and face challenges in effectively managing inventory given the distinct features of different channels.

The objective of this paper is to study the inventory management problems under a bricks-and-clicks structure. We consider a model where a retailer sells a single product in both online and traditional channels. The customers in different channels exhibit different aversions to waiting. The retailer replenishes its stock according to a continuous review (Q, r) policy. The objective is to make replenishment decisions to minimize the retailer's long-run average costs. We show how this problem can be solved and present numerical examples to analyze how certain variables affect the expected costs of the retailer.

There is extensive research on inventory models with multiple demand classes [6-9]. However, few of them consider a combination of backorders and lost sales in multiple demand classes, especially under a (Q, r) policy. Many papers in this stream do not deal with inventory issues [10-12], or simply assume a base stock policy and exponential replenishment lead time [5,13]. One reason for this assumption is that it enables a Markov