Int. J. Production Economics 154 (2014) 233–242

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

Price competition for retailers with profit and revenue targets

Shilei Yang [a], Chunming (Victor) Shi [b,*], Yibin Zhang [c], Jing Zhu [a]

[a] School of Business Administration, Southwestern University of Finance and Economics, Chengdu, Sichuan 610074, PR China
[b] School of Business and Economics, Wilfrid Laurier University, Waterloo, Ontario, Canada N2L 3C5
[c] School of Business Administration, Shanghai Lixin University of Commerce, 201620, China

ARTICLE INFO

Article history:
Received 7 August 2013
Accepted 18 April 2014
Available online 30 April 2014

Keywords:
Price competition
Newsvendor
Profit targets
Revenue targets

ABSTRACT

Price competition for retailers has been extensively studied in the literature assuming the objective of (expected) profit maximization. In this paper, we make a major contribution by studying price competition for retailers with both profit and revenue targets. Consequently, each retailer maximizes her profit and revenue probability, namely, the probability of achieving the profit and revenue targets simultaneously. More specifically, we analyze a scenario where two competing retailers purchase a perishable product from a common supplier and sell to a common market. Employing the isoelastic demand model, we derive the closed-form solutions of the optimal order quantity, the optimal selling price, and the maximal profit and revenue probability for each retailer. It is shown that when revenue is a relevant performance measure, positive and non-positive salvage values lead to different optima for competing retailers. Moreover, as price elasticity and/or price competition intensity becomes higher, the optimal retail price decreases and the optimal order quantity increases for each retailer.

1. Introduction

Price competition among retailers has been extensively studied in several academic disciplines including Economics, Marketing, and Operations Management (see, e.g., Choi, 1996; Png, 1997; Vives, 2001; Bernstein and Federgruen, 2005; Zhao and Atkins, 2008). The basic idea is that retailers often utilize pricing as a strategic tool to compete for customers. As a result, to achieve the best performance possible, when setting her own selling price, a retailer has to take into account her competitors' pricing decisions.

The vast majority of previous studies on price competition assume that retailers' only objective is to maximize (expected) profit, or sometimes equivalently, to minimize (expected) cost. However, this objective, which implies risk neutrality, is inconsistent with two common business practices. The first is that firms or managers are often concerned with not only profit but also performance measures like revenue and return on investment. The second business practice is that firms and managers oftentimes have pre-specified targets on performance measures to achieve. For example, many middle-level managers' compensation may to a large extent depend on whether they can meet or exceed targets on various measures, which are pre-specified by themselves and/or their superiors. Similarly, firms are oftentimes evaluated by investors by if their financial performance can meet or exceed the consensus estimates from industry analysts. Consequently, it is not unusual for firm and/or managers to make decisions to maximize the probability of target achievement.

Out of the many possible performance measures, profit and revenue are arguably two of the most important; while the former represents the longer term interest of a firm, the latter represents a shorter term strategy. Partly due to its importance, public firms are required to report its profit and revenue every quarter. If *either* number reported by a firm is below the target, i.e., the consensus prediction in the market, the firm is very likely severely punished by the stock market. For examples, in the 3rd quarter of 2002, Intel, the largest microchip manufacturer in the world, hit its revenue target but missed its profit target by a small margin. Consequently, its stock price dropped by 15%.[1] For the 2nd quarter of 2005, Yahoo! reported $875 million in revenue, a 44% gain over the same period the year before. However, the consensus revenue estimate was for $881 million. As a result, the stock was down 10% in after-hours trading. This is despite the fact that Yahoo! reported 192 million in profit, in line with market expectations.[2] Furthermore, it is not uncommon for firms to modify profit and/or revenue targets and strive to achieve them based on price competition in the industry. For example, in January 2005, Sony cut its profit target by 31% for the next business year due to intense price competition from companies like Matsushita and Sharp.[3]

* Corresponding author. Tel.: +1 5198840710x2299; fax: +1 5198840201.
E-mail addresses: syang@swufe.edu.cn (S. Yang), cshi@wlu.ca (C. (Victor) Shi), zhangyb@lixin.edu.cn (Y. Zhang), zhuj@swufe.edu.cn (J. Zhu).

[1] "*Intel misses 3Q mark, lowers the bar*", CNNMoney, October 15, 2002.
[2] "*Yahoo slumps as sales fall short*", Market Watch, July 20, 2005.
[3] "*Sony cuts profit target on price competition*", Reuters, January 21, 2005.

http://dx.doi.org/10.1016/j.ijpe.2014.04.022
0925-5273/

Motivated by the above-mentioned business practices, in this paper, we study price competition for two retailers each with her exogenously specified profit and revenue targets. Those two retailers act as price-setting newsvendors, as commonly modeled in the literature (see, e.g., Bernstein and Federgruen, 2005; Brown and Tang, 2006). Both retailers procure a short-life-cycle product from a common manufacturer and sell to a common market. They need to decide on the order quantity and retail price before the selling season. Each retailer's customer demand is affected by the selling prices set by both retailers. However, unlike previous studies which assume the objective of (expected) profit maximization, this paper assumes that those two retailers maximize the probability of achieving both profit and revenue targets simultaneously. For simplicity, we call this probability the profit and revenue probability.

In this paper, we believe that we make several contributions to the existing literature. First, to our best knowledge, we are the first to study price competition for retailers with profit and revenue targets. Hence each retailer maximizes the probability of achieving her two targets simultaneously. Second, almost all existing studies implicitly or explicitly assume that the sign of salvage value makes no difference and many of them simply assume zero salvage value. In this paper, we find that positive and non-positive salvage values may lead to different structural results when revenue is a relevant performance measure. Third, adopting the multiplicative demand model, we obtain the optimal order quantity, the optimal selling price, and the maximal profit and revenue probability for each retailer. We find that as price elasticity and/or price competition intensity increases, the optimal selling price decreases and the optimal order quantity increases.

The remainder of this paper is organized as follows. Section 2 briefly reviews the related literature. In Section 3, we lay a foundation by studying a single retailer under the objective of maximizing the probability of achieving both profit and revenue targets, where positive and non-positive salvage values are treated separately. In Section 4, we study price competition between two retailers using the isoelastic demand model. In Section 5, we compare the optima under our objective and the typically assumed objective of (expected) profit maximizing. Finally, we summarize our major findings and discuss future research directions in Section 6.

2. Literature review

There are two related research streams. The first is on retailers or newsvendors with performance targets. The second research stream is on price competition among retailers.

In the first research stream, earlier researchers focus on a single fixed-price newsvendor with profit target only (Kabak and Schiff, 1978; Lau, 1980; Sankarasubramanian and Kumaraswamy, 1983). Consequently, the newsvendor makes the order quantity decision to maximize the probability of achieving the profit target. A major finding is that the optimal order quantity is independent of the demand distribution. This finding is quite different from the classic fractile solution for the newsvendor who maximizes the expected profit. Lau and Lau (1988) further extend this line of research to a newsvendor with a profit target who sells two independent products.

More recently, Parlar and Weng (2003) study a single newsvendor who balances two desirable but conflicting objectives, i.e., maximizing the expected profit and maximizing the probability of achieving the expected profit. Brown and Tang (2006) identify various performance metrics for retailers (as newsvendors) and analyze their impacts on the order quantity. The performance metrics include meeting a profit target and meeting targets on both sales and gross margin. Shi and Chen (2007) study a supply chain with a single supplier and a single retailer (as a newsvendor), each with a profit target to achieve. One of their interesting findings is that simple wholesale price contracts are capable of coordinating such a supply chain. Wang and Webster (2009) study a loss-averse newsvendor, which is equivalent to a newsvendor with a profit target when the loss-aversion coefficient is sufficiently large. He and Khouja (2011) investigate a supply chain with a single supplier and a single retailer where one or both have profit targets. They study three different supply chain contracts, namely, Push, Pull, and Advance-Purchase Discount contracts. Yang et al. (2011) study a single price-setting newsvendor with both profit and revenue targets. They assume the salvage value is strictly positive and the issue of competition is not addressed. Our paper builds on Yang et al. (2011) and incorporates non-positive salvage value as well price competition. Finally, Jammernegga and Kischka (2013) analyze a newsvendor model by incorporating two conflicting objectives simultaneously: a service level target and a constraint on the probability of loss.

There have been extensive studies in the second research stream of price competition in different disciplines such as Operations Management and Marketing. Choi (1996) deals with price competition of two competing retailers, each sells substitutable products from two competing manufacturers. Padmanabhan and Png (1997) study the strategic effect of return policies on two retailers under price competition. Tsay and Agrawal (2000) study a channel with one common manufacturer and two competing retailers under deterministic customer demand. Those two retailers engage in both price and service competitions simultaneously.

More recently, Chen et al. (2004) study price competition for retailers under fairly general demand models. They show that retailers tend to under-price at the equilibrium. Bernstein and Federgruen (2004) analyze a periodic-review infinite-horizon model where multiple retailers engage in both price and service competition. Bernstein and Federgruen (2005) focus on coordinating a supply chain with one supplier and multiple retailers engaging in price competition under the single-period stochastic customer demand. Zhao and Atkins (2008) provide a novel method to establish the existence of Nash equilibrium when both inventory competition and price competition coexist. Xiao and Qi (2008) examine price competition for two competing retailers when the production cost of their common supplier is disrupted. Zhao (2008) investigates a supply chain where downstream retailers are engaged in both price and inventory competitions. She establishes the existence and uniqueness of the pure-strategy Nash equilibrium for the retail game and studies how the upstream supplier can design contracts to achieve supply chain coordination. Cai et al. (2009) study price competition between a retailer and the online channel of its supplier. They consider three possible games: retailer Stackelberg game, supplier Stackelberg game and Nash game depending on who moves first to set its selling price. However, their focus is on supply chain coordination and they adopt linear deterministic demand functions. Zhao and Shi (2011) analyze two competing supply chains, each with multiple complementary suppliers selling to a single buyer. Adopting the multiplicative demand model, they look into production and pricing games and find that decentralization may benefit a supply chain when price competition is intense. Mukhopadhyay et al. (2011) investigates two firms selling complementary products which set the selling prices in a Stackelberg game. The authors focus on possible opportunistic information sharing behavior and how to design coordination scheme to achieve Pareto improvement for the supply chain. Finally, Wu et al. (2012) consider a supplier chain consisting of a common supplier and two competing retailers. They focus on price competition between the retailers under six game models depending different sequence