دهمین کنفرانس بین المللی مهندسی صنایع
Tenth International Industrial Engineering Conference
۷ و ۸ بهمن ماه ۱۳۹۲
27-28 January, 2014

Optimizing differential return on investment pricing, lotsizing and shipment in a two-echelon supply chain

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***Abstract*— In spite of studies, investigating differential pricing and lotsizing problems in inventory- marketing models individually, this paper addresses them simultaneously aiming to maximize return on inventory investment. A two echelon supply chain is studied that involves a retailer who faces demand from two or more market segments and enable to set different prices and marketing expenditures and a supplier who desires to find optimal number of shipments through an integrated system. A new fractional mixed-integer non-linear programming model is developed to determine optimal ordering, shipping and differential pricing and marketing expenditure quantities simultaneously. A simulated annealing algorithm is also applied to solve the resultant non-linear model. The parameters of the devised SA are calibrated via Taguchi method.**

Keywords- Optimization; Differential pricing; Supply chain; Return on inventory investment; Fractional programming

I. INTRODUCTION (HEADING 1)

An up-to-date review [1] reveals there is a growing literature in presenting and analyzing optimization models integrating pricing and lotsizing policies. In today's global markets, the revenue management (RM) models are becoming a powerful instrument, where a retailer industry desires to provide different levels of marketing mix (named four P's: price, product, promotion and place) to different market segmentations (i.e. channels). Since the pioneering review research of [2], the concept of inventories' price differentiation has been one of the most pervasive activities in both the marketing and operations academic literature and practice.

One of the underlying principles of RM is to divide a single market into multiple sub-markets/segments and then set different prices in each sub-market. Price differentiation is a powerful way for sellers to improve their profitability [3]. Sen and Zhang [4] considered the newsboy problem with multiple demand classes, where demands were realized sequentially and demand dependency was modeled through the diversion. Zhang and Bell [5] extended the newsvendor problem with backlogged demand to the case where the single product can be sold to different demand classes at different prices. Zhang et al. [6] evaluated the simultaneous determination of price and inventory replenishment in a two-segment market with a fence. All of these research papers focus on profit aspects of the retailer/manufacturer without any other criterion.

Ghasemy Yaghin et al. [7] presented a joint pricing and lot-sizing model with multiple demand classes to set different prices and marketing expenditure in each sub-market. Traditionally, numerous papers have employed the profit maximization or cost minimization as their objective in designing and analyzing inventory models. Many researchers also optimized the inventory systems under return on investment (ROI) maximization. As Lenskold [8] mentions, it is completely reasonable, and highly beneficial, to expect a return on investment for each incremental marketing dollar spent. An inventory model using the criterion of ROI maximization is proposed by [9]. Also, Rosenberg [10] compares and contrasts profit maximization versus return on inventory investment with respect to logarithmic concave demand functions. Otake et al. [11] proposed an ROI maximization model with the lot size and setup cost reduction investment as the strategic joint decision