Chapter 13
Pricing and Lot-Sizing Decisions in Retail Industry: A Fuzzy Chance Constraint Approach

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ABSTRACT
Analysis of inventory systems involving market-oriented pricing decisions has recently become an interesting topic in the field of inventory control. Price and marketing expenditure are considered as important elements when selling goods and enhancing revenues by manufacturers. The importance of accounting for uncertainty in such environments spurs an interest to develop appropriate decision making tools to deal with uncertain and ill-defined parameters (such as costs and market function) in joint pricing and lot-sizing problems. In this research, a fuzzy chance constraint multi-objective programming model based on p-fractile approach is proposed to determine the optimal price, marketing expenditure and lot size. Considering pricing, marketing and lot-sizing decisions simultaneously, a possibilistic programming based on necessity measure is considered to handle imprecise data and constraints. Discount strategy as a fuzzy power function of order quantity is determined. After applying appropriate strategies to defuzzify the original possibilistic model, the equivalent multi-objective crisp model is then transformed by a single-objective programming model. A meta-heuristic algorithm is applied to solve the final crisp counterpart.

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1. INTRODUCTION

Inventory control has been studied for several decades for cost savings of enterprises which have tried to maintain appropriate inventory levels to cope with customer demands and to boost their image through customer satisfaction (Axsäter, 2000). One of the key factors to improve service levels of the enterprises is to efficiently manage the inventory level of each participant within supply chains. Traditional inventory models do not involve the relationship between the sales price and the economic order quantity. When demand for a product is price sensitive, pricing and lot sizing decisions are intertwined and collectively solved as a joint pricing and lot-sizing model.

The integration or coordination of production and marketing functions has been known to be crucial in practice for diminishing their conflicts and increasing a firm’s profit by reducing opportunity losses incurred from separate or independent decision-making (Freeland, 1982; Kotler, 1971; Porteus and Whang, 1991; Kunreuther and Richard, 1971; Lee and Kim, 1993; Kim and Lee; 1998). One important area is joint pricing and lot sizing model (JPLM), which concerns simultaneous determination of an item’s price and lot size or economic order quantity (EOQ) to maximize a firm’s profit for constant but price-dependent demands over a planning horizon. The marketing effort influences demand and, consequently, the firm profit. Marketing effort motivates sales and influences potential consumers with an immediate reason to buy (Huang and Li, 2001).

Managing a marketing-inventory system effectively to fulfill the customer service levels is very difficult, since various sources of uncertainty and complex interrelationships between marketing and operation departments exist in the system. Additionally, the changing product life cycle and the heightened expectations of customers have also made the marketing-inventory systems even harder to manage, especially for new products in marketplace. Although the new products can enable a company to achieve higher profit margins, they make demands for them unpredictable, because no historical data is available (Fisher, 1997). Most of the research for developing inventory strategies (Wang and Shu, 2005) modeled the inventory uncertainty (e.g., uncertain demand) by probability distribution that is usually estimated from historical data. However, whenever statistical data is unreliable or even is not available, the stochastic models may not be the best choice. Therefore, real-life scenarios require marketing parameters to be of imprecise type i.e. uncertainty is to be imposed in non-stochastic sense (Ghasemy Yaghin and Fatemi Ghomi, 2012). Furthermore, a decision maker (DM) often has vague goals such as “This profit function should be larger than or equal to a certain value.” For such cases, fuzzy set theory and fuzzy mathematical programming methods should be used (Wee et al., 2009) and may provide an alternative approach to deal with the JPLMs uncertainty.

The chapter belongs to the rapidly growing literature on joint inventory and pricing models. The objective of this chapter is to develop and analyze a chance constraint multi objective pricing and lot-sizing model in a fuzzy environment. In order to determine economic production quantity and market decision variables, the two important objective functions, i.e., profit, return on inventory investment (ROI) are taken into account. Notably, in an inventory and marketing planning, objectives’ goals, unit costs and marketing parameters, etc. are often assumed to be crisp and defined with certainty. But in practice, this is seldom the case so that the goals and parameters are normally vague and imprecise. Therefore, this paper presents a fuzzy multi objective programming method based on necessity to capture this inherent fuzziness in the critical data and goals.

The reminder of this chapter is organized as follows. In the next section, the relevant literature is reviewed. Main focus of the chapter, problem description, assumptions and formulation are presented in Sections 3 and 4. Then, through applying efficient defuzzification strategy, the resultant equivalent crisp model is solved with