International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Using Revenue Management in Multiproduct Production-Inventory Systems

Hadi Esmaeili Ahangarkolaei[1], Mohammad Saeid Zandi[2]

Department of Production economics Linkoping Institute of Technology

Abstract: ***The study aims at investigating how revenue management techniques can be applied in industries which offer multiple products. Most of the companies nowadays trend to produce multiproduct and they try to find the best method of selling. Therefore, revenue management can be considered as a new direction which should be developed for these firms. In this study, multi-product firms are mainly referred as firms offering a bundle of products or substitute products. The main findings of this study are (1) identifying and analyzing the most important factors affecting decision making regarding managing of bundling and substitute products and ultimately total revenue of multiproduct firms. (2) Summarizing the results and knowledge obtained from various studies within fields of bundling and substitute products. (3) Discussing the possibility of applying different revenue management techniques to these fields. (4) Identifying potentials and new directions for future study with respect to both revenue management techniques and multiproduct firms.***

Keywords: Revenue Management, Multiproduct, Bundling Product, Substitute Product, Assortment Planning, Pricing, Inventory Management.

1. Introduction

Today's business and highly competitive markets force firms to coordinate their activities along with customers' desires and needs. Customers are more demanding than they used to be. They want more newly developed and customized products and seek for possible variety in their choice. For example, in a store shop one customer may be willing to buy an expensive prestigious brand of jeans, but another customer is only willing to pay for regular or low quality jeans. Consequently, firms are required to be highly flexible [1]. Manufacturers should be able to develop their product lines to produce products with more variety . Moreover, they cannot produce as many units as they prefer to stock and sell in the market since products' life cycles are getting short and customers' preferences change rapidly. Retailers also have to anticipate customers' heterogeneous demands and carry not only different categories of products, but also different variety of one or similar products to satisfy diverse needs and preferences of customers. This diversity of needs has forced firms to change their marketing strategies from serving the whole market with the same product towards serving the market with several products, each for satisfying a specified portion of the market. Companies which offer different products or one product in several varieties are referred as multiproduct firms. Managing the business of multiproduct companies is a complex task. There exist many firms in each market, competing for customers, which lead to a high price competition. Most of firms, nowadays, produce and sell different types of products through their sale channels, therefore managers must manage their products as well as the inventories and prices of these products in a way that they avoid high amount of unsold goods, loosing market shares and other difficulties [2]. On the other hand, they should be able to satisfy their customers with proper products and services, reasonable price and availability of their products in order to survive in the market. New marketing and selling techniques have been developed to cope with these difficulties and to enable firms in making the maximum possible revenue from their production and sales activities. Revenue management is a contemporary concept which aims to improve the firms' revenue through understanding customers' behavior, forecasting their needs and demand in a real time, and adjusting firms 'activities (e.g. production, marketing, sales) over time to respond the customers' behavior and the changing of market condition. Revenue management applications are well-known in service industries such as airline industries; however, its applications in many other industries are not well studied in literature or utilized in practice e.g. manufacturing industries .Therefore, in this master thesis we are motivated to focus on identifying and analyzing managers' problem in regard to managing multiple products, and application of revenue management techniques in multiproduct firms [3].

2. Basics of Revenue Management

It is obvious that the most important objective of almost all firms is to increase the total profit of the firm through providing different services and products for customers in order to compete and survive in the market. On the other hand, in today's business there are numerous uncertainties in selling a product or service to customers and companies are acquiring whatever tools and techniques needed to cope with these uncertainties or even to take advantages of them. Competition forces firms to better and more carefully understand the importance of customer value for the products or services, which is diverse and plays a critical role in revenue and profit. The time at which a customer desire to purchase a product or service, where and at what place customers prefer the product to be available, the value customers assign to products and the prices they are willing to accept for different products ,are decisions and issues which should be considered by firms who seek to obtain the highest possible profit from customers. These decisions are not easy to make since customers are not the same in their behaviors. Customers show different buying behaviors, they assign values in different ways for a particular products and the market for products are getting divided into much smaller and more distinguished segments where needs of customers within each segment differ. Revenue management

is a very useful concept to make the decisions above easier and to provide firms the techniques and tools in order to maximize their expected profit in the competitive and diverse market. Revenue management can be implied as a system which aims to understand and anticipate consumers' behavior and effectively react to them in order to maximize profit of the firms. There are several synonymous names for revenue management; such as yield management, price and revenue optimization and demand management. Consequently there are several definitions for revenue management, but the recent and perhaps the best definition so far is as follow; Robert G. Cross author of the book "Revenue Management – Hard-Core Tactics for Market Domination" define revenue management as "the art and science of predicting real-time customer demand at the micromarket level and optimizing the price and availability of products" [4].

3. Bundling Products

Bundling product as one of the common techniques in selling products is getting popular nowadays. Also, firms producing multi-product are trying to use bundling concept to take advantages of bundling from different perspectives which will be described here. Moreover, bundling can contribute to raising revenue if we can use this technique in proper ways.

Here we define basics of bundling concepts. A classic definition of the bundling is "the practice of marketing two or more products and/or services in a single package for a special price" [5] however, the definition is very general. We can classify bundling techniques in terms of bundling pricing and bundling product as follows:

1- Price bundling: two or more products are sold together at a discount price than the sum of selling individual products.

2- Product bundling: two or more products are sold together at any price. Therefore, the price of the bundle could be even higher than the sum of the prices of the products .This situation occurs when the integration of the products needs a special skill or adds value from customers' point of view. The best example could be computer manufacturer that integrates different components and delivers as a PC at any price which can be even higher than the sum of the price of all components; but the customer pays because she knows that integration of the components needs special technology and this process made by the manufacturer has an added value for the customer. So the customer is willing to pay more because of this additional value .

4. Substitute Products

It is a common experience that a customer goes to a store and expects to buy a particular product but she ends with another similar product instead. This behavior of customers is called "substitution". Consequently, substitute products are defined as: "goods that can be used to satisfy the same needs, one in the place of another. The buyer carries out an actual and conscious process of choice about them, which leads the buyer to prefer one to another" [6]. A few examples can make the definition more clear; a customer wants to buy a specific brand of milk, but since she cannot find it, she buys from another brand. A white shirt can be bought by a customer in case that her preferred red shirt is sold out. The different brands of milk and the white vs. red shirts in examples above are substitutes for each other. In addition, in some cases, a product can be a substitute for itself; e.g. a new developed version of software may be purchased at a higher price instead of the old version. Fresh doughnuts and old doughnuts can be substitute goods if a seller offers a discount for old doughnuts to get rid of them. The common aspect of the mentioned examples is that these substitute products satisfy the similar needs of consumers and consumers have the power to decide which product to prefer and purchase. The definition of substitute products described above is different from classical economic view about them, to some extent. In classical textbook of microeconomics these goods can be of any types as long as consumers accept one product instead of the other. In other words, substitute products are not limited to satisfy the same needs of customers. For example a car can be a substitute for a house for a particular customer in case of budget constraint; he/she cannot afford buying a house. To be more specific about our view of substitute products and their characteristics, it is worth to describe why consumers prefer some products to others, or why they are indifferent about some of them and willing to accept a substitute product. The fundamental concept of substitute products is derived from theory of consumer preferences which will be expressed in following section.

5. Inventory management problem of substitute products

When a retailer sells similar products, she has to be aware of substitution effects among them. In presence of substitution, demand for a particular product is not only influenced by its own characteristics, but also the inventory level of products with similar characteristics [7]. It implies that the observed sale of an item is no longer equal to its core consumer demand (the case where all items are available). Sales of items which are stockout can be underestimated because they only can be met to the extent of available stock; on the other hand sales of other items can be overestimated since a portion of demand comes from consumer substitution. "Assume there are 50 units of product A and 30 units of product B at a store. Assume further, B is sold out soon and A is sold out after a while since A is more in number. Then the result you get is that 50 of A and 30 of B are sold. However the product that really sells is B", stated by Mr. Toshifumi Suzuki, chief executive of Seven & Eleven of Japan to demonstrated a possible biased interpretation if substitution is ignored [8]. As a result, forecasting the accurate demand for each product and determining its right order quantity to assure maximum profit is difficult for retailers. Retailers should incorporate inventory decisions of all products when selling substitute products. For example, one may expect to reduce the safety stock of a particular item since she can count on other items to be sold as substitute in case of high demand or by adjusting the price she make some products substitute for others to avoid stock-outs. It may lead to lower stocking costs. Reality shows retailers frequently buy too little volume of some products, which results in lost sales and profit margins, and too much of other products whose prices then are marked down at the

end of season [9]. Only these inventory related costs is count for $25 billion a year in the U.S retail industry [10].

6. Consumer choice

Understanding the nature of consumer behavior facing discrete choice has a great significance in marketing and operation research specially literatures in multiproduct revenue management which is the focus of this study. Discrete choice models are statistical procedures that model choices made by people among a finite set of alternatives. Discrete choice models statistically relate the choice made by each person to the attributes of the person and the attributes of the alternatives available to the person. For example, the choice of which car a person buys is statistically related to the person's income and age as well as to price, fuel efficiency, size, and other attributes of each available car. The models estimate the probability that a person chooses a particular alternative.

7. Choice Set

The choice set is the set of alternatives that are available to the person. For a discrete choice model, the choice set must meet three requirements:
1. The set of alternatives must be exhaustive, meaning that the set includes all possible alternatives. This requirement implies that the person necessarily does choose an alternative from the set.
2. The alternatives must be mutually exclusive, meaning that choosing one alternative means not choosing any other alternatives. This requirement implies that the person chooses only one alternative from the set.
3. The set must contain a finite number of alternatives, meaning that there are a countable number of alternatives in the set. This third requirement distinguishes discrete choice analysis from regression analysis in which the dependent variable can (theoretically) take an infinite number of values.

8. Literature Review

The aim of this section is to review recent and the most significant literatures concerning managing substitute products. To review papers we group literatures to four groups to be easy to follow. In the first group we study literatures concerning inventory management of substitute products, either general inventory management or newsvendor models. In the second group first we briefly review product line design (PLD) problem literatures and consequently literatures involving assortment planning problem will be discussed. In the third group papers concerning dynamic pricing of substitute product will be reviewed, and in the forth group we review papers which study joint inventory-pricing of substitute products. There may be some subgroups within each group, if appropriate, to further classify literatures. While reviewing each paper we describe the problem, the assumptions made, the structure of the model and solving approach. Important parts of models, particularly demand functions, may be discussed more in detail and finally results will be highlighted. At the end of this part we will make a classification table for papers based on characteristics below:

Length of time horizon: Problems are usually modeled using a single period (newsvendor) problem, however some papers assume multiple periods. We distinguish the length of horizon while reviewing papers.

Price: Price of products can be categorized based on two terms. Prices can be exogenously given, for example determined by the competitive market, or to be endogenously determined through optimization. Price also can be remain fixed through selling horizon or dynamically changed as a function of inventory, demand, etc. Adding pricing problem to the models makes them more complex.

Costs: Commonly there is a fixed procurement cost for products. This cost may be equal for all products variants or not. Also some papers consider holding and shortage cost in their models, but many of them ignore holding and shortage costs as well as salvage value for overstocked products. We will distinguish these characteristics of models as well.

Supply process: Most of papers assume no restriction on the supply process. Such restriction may involve limiting the number of variants included in the assortment or shelf space restriction since in long run they can be relaxed at some costs. It is common to have zero lead time for inventory replenishment if inventory replenishment and dynamic assortment is allowed. When appropriate, we note these assumptions in literatures.

Substitution: The importance of substitution type is remarkable in modeling since it usually determines the primary demand function and solving approach. We note substitution type and all assumption made in substitution behavior of consumers.

Demand function: The most important distinction of demand type is whether it is deterministic or stochastic. In deterministic model, demand is a known function of some parameters like price. But in stochastic models it consists of a known part as well as a stochastic or random part. Consumer behavior, such as arrival process and particularly preference are important parts of a demand functions.

9. General Inventory management with substitute products

Gerchak and Mossman [11] explore the effects of demand randomness and risk pooling on optimal inventory levels and associated costs. In contrast with intuition, they show that there are some specific conditions where the optimal inventory levels may increase due to risk pooling and substitution effects.

Drezner et al [12] develop an economic order quantity (EOQ) model in presence of two substitutable products. In their model one product can be substitute for the other product, at a fixed cost. Authors' intuition was that if accounting for substitution is profitable, then the rate of substitution does not matter and either no substitution is optimal or complete substitution is optimal. Surprisingly

results show that full substitution is never optimal and either no substitution or partial substitution is optimal. They prove when the difference in holding costs of two products are sufficiently large, then the total cost of partial substitution is marginally lower than cost of full substitution.

Yang and Scharge [13] study the situation where risk pooling particularly full and partial substitution increase inventory levels. They indicate that in case of full substitution and right skewed demand distribution, optimal inventory levels increase, also in case of partial substitution and symmetric demand distribution such as normal and uniform, they show conditions when inventory levels increase. The papers reviewed above where general inventory models trying to investigate effects of substitution on total costs and order quantity of substitutable products. Another stream of research concerning substitutable products is inventory management of substitutable products under newsvendor setting, which is more relevant to purpose of this thesis and nature of revenue management models.

10. Conclusion

As mentioned in version these decision are mostly strategic and based on the nature and type of problems different techniques are applied to solve them and find the optimal policy. We categorize the structural decisions that are relevant to concept of bundling and substitute products as follows:

10.1 Bundling products

- Finding the best bundling strategy over the three strategies; pure bundling, mixed bundling and pure component.
- Strategic decision regarding whether or not making a compatible product with the competitors' products in a non-monopoly market.
- How to change the bundling strategies over life cycle of the products or the bundle to ensure maximum profit.
- In the literatures which we have reviewed in text, finding the best bundling strategy has been considered in many literatures. Market segmentation has been mentioned as one of the most important factor in applying RM techniques, however, it has not been considered clearly in the literatures which aimed to find best bundling strategies. The other important issue which is yet to be considered in literatures is the significance of products' life cycles and how selecting optimal bundling strategies would change over products' life cycles.

10.2 Substitute products

- Finding the optimal assortment of substitute products to stock.
- Determining the products to be introduced in a product line of substitute products.

All the literatures we reviewed regarding these decision were about finding the structure of optimal assortment or products within a product line, however, issues such as how this optimal structure may change over time and life cycle of products or how introduction of a new product affect this structure are yet be investigated.

References

[1] Nalebuff A. Bundling, tying, and portfolio effect". Part I: Conceptual issues. Tech. report, Department of Trade and Industry, London, United Kingdom 2003.
[2] Matutes, C., P. Regibeau. Compatibility and bundling of complementary goods in a duopoly". Journal of Industrial Economics XL (1), 37–54, 1992.
[3] Lancaster, K. Socially optimal product differentiation". American Economic Review. Vol 65, 567-585, 1975.
[4] Cross, Robert G. Revenue Management: Hard-core tactics for market domination", Published by Broadway Books, New York. ISBN 0-7679-0033-2, 1997.
[5] Guiltinan, J.P. The Price Bundling of service: A Normative Framework". Journal of Marketing,74-85, 1987.
[6] Piana,V. Substitute goodsAvailable at: http://www.economicswebinstitute.org/glossary/substitute.htm. Last accessed 17th.Sep.2010.
[7] Rajaram, K., C. S. Tang. The impact of product substitution on retail merchandising". European. J. Operational. Research. Vol 135,No 3, 582-601, 2001.
[8] Anupindi, R., M. Dada and S. Gupta. Estimation of Consumer Demand with Stockout Based Substitution: An Application to Vending Machine Products," Marketing Science, Vol 17, 406-23, 1998.
[9] Karakul, M. Chan, L.M.A. Analytical and managerial implications of integrating product substitutability in the joint pricing and procurement problem". European Journal of Operational Research ,Vol 190,179–204, 2008.
[10] Ferrer, J.C., H.Mora, F.Olivares . On pricing of multiple bundles of products and services". European Journal of Operational Research. Vol 206, No1, 197-208, 2010.
[11] Grchak, Y. and Mossman, D. On the effect of demand randomness on inventories and costs". Operations Research, Vol 40, 804-807,1992.
[12] Drezner Z., H. Gurnani, and B.A. Pasternack . An EOQ Model with Substitutions Between Products," Journal of the Operational Research Society, Vol 46, 887-893, 1995.
[13] Yang, Hongsuk & Schrage, Linus. Conditions that cause risk pooling to increase inventory," European Journal of Operational Research, Elsevier, Vol 192, No3, 837-851 104. Yücel, E. 2009.