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Innovative Applications of O.R.

Pricing problem in wireless telecommunication product and service bundling

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ABSTRACT

This paper investigates a mixed bundling problem in the wireless telecommunication business. Customers can buy cellular phones at a discount price if they subscribe to a service plan with the price above a threshold. We have proposed using nonlinear mixed-integer programming to determine the optimal price to maximize the total profit of the service providers. An efficient algorithm has been presented to solve this problem when discrete demand data is available. We have compared the profits from three strategies: individual sale, mixed bundle and pure bundle. Our analysis suggests the condition under which the mixed bundle strategy outperforms other strategies. We have also studied the impact of parameters on the solution. The results of the analysis may help the service providers adjust their pricing schemes according to changes in the market. In the case of incomplete information (only the distribution of the demand is known), we apply another research approach (partition graph) to determine the optimal bundle price.

1. Introduction

Bundling is now a widely applied market strategy. Many firms bundle their products and/or service together. There are many reasons why the firms bundle products and/or service, for instance, increasing market share and sales, improving customer service, reducing logistics and transaction costs, applying economics of scales, etc. All of these could eventually contribute to increased profitability.

There are several types of bundling strategies. Pure bundling is a strategy in which a firm sells only the bundle and not the products separately. Unbundling or individual sale is a strategy in which a firm only sells the products separately. Mixed bundling refers to a strategy in which a firm sells both the bundle and each of the products in the bundle separately. Customized bundling is a pricing strategy that gives consumers the right to choose up to a quantity M of goods drawn from a larger pool of N different goods.

Our paper examines the bundling problem in the wireless telecommunication market. Since the 1990s, the wireless telecommunication industry has developed dramatically. The number of cellular phone holders and mobile telecommunication service users has increased exponentially all over the world. The competition in this market is also fierce. The demand for cellular phone services is quite price-elastic. The research of Atsushi (2005) has stated that the estimated elasticity is from 1.30 to 2.43 in absolute value. Customers are sensitive to the price of the cellular phone and service. A special relationship exists between the cellular phone and the service: holding a cellular phone is the prerequisite of using a wireless telecommunication service. Some customers do not use the service because they do not have cellular phones. However, if a service provider provides a cheap or even free cellular phone to them, they will use the service.

Acquiring new customers is critical to the survival of service providers. The statistical analysis carried out by Ranganathan et al. (2006) has supported these hypotheses: frequent and continued users of a service are likely to develop a strong and presumably positive attitude about the service; and the duration of the user-provider relationship as well as service bundling will be negatively related to the switching behavior of mobile users. Once the new customers subscribe to a service plan, they probably will continue to use the service. Thus, the service providers try every effort to attract new customers.

Another interesting feature of the market is the profits of different service plans. Nowadays the service providers provide many new services for customers. Besides making and receiving calls, these new services allow customers to access a wide range of information and entertainment. The monthly fees of the service plans vary greatly according to the contents of the plans. Higher price plans include more free call services, allow customers to browse more information channels and provide picture mails, etc. Similar to other information goods, the service has a very low marginal cost. Most of the service cost is the fixed equipment or IT system investment. If the service providers have already invested and set up the equipment, and develop the necessary IT system, the

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marginal service costs of service plans do not vary much. Service plans with high prices usually generate higher profit. Thus, the service providers not only try to attract new customers, but also hope to subscribe them to expensive service plans.

Due to the above reasons, service providers widely use a bundling strategy. Usually they bundle the cellular phone and the service plan together. In the bundle, a cellular phone is sold at a discount price. However, the customers are required to subscribe to a service plan for a certain period. Although the customers have many service plans to choose from, the monthly fee of the service contract they subscribe to must be higher than a threshold. The service providers' objective is to attract more customers to their service plans with higher profits and increase their long-term profits. However, to realize this potential, it is critical for the service provider to determine the optimal bundle prices.

In this paper, we address this issue of determining the optimal prices to maximize the long-term profit of the service providers. In the following section, we give a brief literature review on bundling. Then we present our model and perform the analysis. We study a general mixed bundling strategy and formulate the problem as a nonlinear mixed-integer programming problem. Since the problem is complicated to solve, we consider a simpler case where the price reduction of the cellular phone is set equal for all cellular phones. We develop an algorithm to find the optimal price. This algorithm provides a practical approach for the pricing problem. Next, we establish several lemmas. We compare the three bundling strategies and analyze the impact of parameter change on the solution. These results provide some managerial insights for the telecommunication service business. We also discuss the case where only demand distribution is known (incomplete information), and we present another approach to obtain the optimal price in this case.

2. Literature review

The bundling problem has been examined by many researchers in different aspects. Stremersch and Tellis (2002) have clearly defined bundling terms and identified two key dimensions that enable the classification of bundling strategies. They have proposed a framework of 12 propositions that suggest which bundling strategy is optimal in different contexts.

Some articles examined the benefit of bundles and have provided theoretical rationales for the bundling concept and the conditions where a bundling strategy is suitable. Stigler (1963) has discussed how bundling can increase a seller's profits when consumers' valuations for two goods are negatively correlated. Adams and Yellen (1976) have analyzed the rationale of price discrimination. Kenney and Klein (1983) have stated that bundling can reduce classification/classification costs. Guiltinan (1987) has provided a normative integrated framework for the theoretical rationales for bundles. Baumol et al. (1982) have addressed the effect of bundling in scope economies. Eppen et al. (1991) have examined a bundle's impact on product range restriction. Lancioni and Gattorna (1992) have discussed the use of bundling in strategic pricing and have claimed that bundling is used as a response to a competitive price move or in an attempt to extend the life cycle of a mature product. Herrmann et al. (1997) have examined the factors of bundling on consumers' intentions to purchase product and service bundles. Mankila (2004) has investigated the issue of customer retention of students in retail banking through a price bundling approach. Mankila has found that bundling several banking services at a discount price can create incentives to stay through time and improve customer retention.

There are some other articles investigating the pricing problem in a bundle and evaluating different bundle strategies. Adams and Yellen (1976) have compared different bundling strategy policies for two products when the reservation price of customers is known. McAfee et al. (1989) have extended their model to the case where the reservation prices for two products are independently distributed in the population of consumers. Venkatesh and Mahajan (1993) have proposed a probabilistic approach to optimally set the price of a bundle of entertainment packages that maximizes sellers' profit. They assumed consumer purchase decisions to be a function of a customer's available time and reservation price per performance. McCardle et al. (2007) have developed models to calculate the optimal bundle prices, order quantity and profits for bundles of retail products. They have claimed that bundling profitability depends on individual product demands, bundling costs, and the nature of the relationship between the demands of the products to be bundled. Bulut et al. (2009) have examined different bundling strategies for two perishable products with Poisson demand arrivals and a bivariate reservation price distribution. They have determined the optimal product and bundle prices that maximize the expected revenue.

The rapid growth of information technologies and goods has led researchers to investigate the bundling problem of information goods. Information goods are presumed to have very low marginal costs. Chae (1992) has analyzed a subscription TV market where bundle is used due to economies of scope in distribution technology. He has studied the pricing and production decisions of a supplier as well as the impacts of certain regulations. Bakos and Brynjolfsson (1999) have discussed the pricing and profits when marginal costs are negligible and customers have identically distributed valuations. They have shown that pure bundling of large numbers of goods is optimal. Chung and Sirbu (1999) have proposed an N-good bundling model with multi-dimensional consumer preferences for journal publishing. They have established that mixed bundling is the dominant strategy. Wu et al. (2008) have used nonlinear mixed-integer programming to solve the customized bundle pricing problem in which consumers are allowed to choose up to N goods from a larger pool of J goods. They have considered the tradeoff between offering more choices and incurring greater menu cost. Fana et al. (2009) have used a game theoretical approach to analyze the bundling of a software product with a delivery and maintenance service. They have shown that bundling software with service lowers the software implementation cost for users and increases the service operation cost for service providers.

Our research is on a pricing and maximizing profit problem. We examine product and service bundling in the wireless telecommunication market. The product refers to a cellular phone; the service refers to a series of wireless telecommunication service plans. The wireless telecommunication service provides information goods at low marginal cost. The cellular phone is a typical product with a high unit cost. In the telecommunication business, attracting customers and increasing demand are very important factors. As discussed in the introduction, the service providers try their best to attract new customers. To increase profit, they also try to attract customers to subscribe to expensive service plans.

The service providers design a bundling strategy, selling the cellular phone and the service plan in a bundle. This bundling problem has some special features different from other researches. The cellular phone has two kinds of prices, the normal price when it is sold separately, and the discount price (bundle price) when it is bundled with a service plan. Customers can choose many service plans. However, the service providers determine a threshold price. The cellular phone only bundles with the service plan whose monthly fee is equal to or higher than the threshold. The customers are also required to subscribe to a service plan for a certain period. The service providers not only consider the current profit, but also future profit. They may even sacrifice current profit for long-term