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Bundle-Pricing Decision Model for Multiple Products

Yan Fang[a]*, Lijun Sun[b], Ying Gao[c]

[a] *School of Business, Dalian University of Technology, Dalian, 116023, China, Nanjing 210096*
[b] *Institute of Systems Engineering, Dalian University of Technology, Dalian, 116023, China*
[c] *School of Software Technology, Dalian University of Technology, Dalian, 116023, China*

Abstract

Bundling is an efficient method to achieve business objectives in many industries. However decisions of bundle selection and pricing are complicated when multiple products are involved. In this paper, we investigate a bundle-pricing decision model for multiple products. With the objective to maximize the retailer's profit, an integrated bundle-pricing model for multiple commodities is formulated as a Non-Linear Mixed Integer Program based on the framework of Stackelberg game. By adding auxiliary decision variables, this model is converted into a Mixed Integer Linear Program and solved by Cplex. Numerical experiments and sensitive analysis are conducted to provide managerial insights for bundling multiple products. It indicates that low consumption level consumers prefer bundles composed of more commodities with lower prices. The products with higher cost level should be bundled with smaller bundle size and higher prices.

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Keywords: Bundle-Pricing; Multiple products; Mixed Integer Programming

1. Introduction

Bundling means to sell more than one goods or services by package at a more attractive price compared with to sell separately. It is an efficient method to achieve business objectives and has been proven in many industries, for example grocery retailers[1], television providers[2] and holiday packages[3]. Bundling is regarded as an opportunity to

* Corresponding author. Tel.: +86-13500710339.
E-mail address: fangyan_51@hotmail.com

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increase revenues because it can extract consumer surplus from heterogeneous customers. Decisions of bundle selection and pricing are complicated when multiple products are involved[4]. For example, when a firm provides N products, the number of different bundles will be 2^N-1. Clearly, the bundle selection and pricing will be very complex when N is large. How to decide which products to be sold in a package? How to determine optimal prices to maximize the company profit? These are not easy matters for most companies.

The composition and pricing of bundles have been widely studied. Bundle sells can eliminate the heterogeneous of customers and extract customer surplus in order to achieve economic and marketing goals[5]. There are two streams of bundle-pricing literature. The first stream is from the strategic level to bundle a typical kind of products, for example, information product[6], food product[7] and so on. Managerial insights are provided from strategic level. The second stream is from the operational level with focus on how to give an optimal scheme of pricing and composition of bundles. The mostly used methods are probability model[8], Bayes model[9] and MILPs(Mixed integer linear programs)[10]. MILPs are efficient when the number of products is large[11]. A mixed integer linear programing model was proposed by Hanson and Martin (1990)[10] to address the bundle and pricing problems for the first time. Then some academic work extended the model to adapt to new problems. For example, Jiang(2011) [1] proposed a multistage online bundle method, and Mayer(2013)[3] considered the bundle problem with capacity constraints. Wu[12]studied the customized bundle under which consumers decide on the composition of the bundle while the seller determines the size and price of the bundle. And the cardinality of the set of solutions increases linearly with the number of single products[3]. However, when the marginal costs of products are high and different between each other, the customized bundle cannot be implemented.

In this paper, we investigate the mathematical formulation of bundle selection and pricing decision for multiple products. With the objective of optimizing seller's profit, an integrated bundle-pricing model for multiple commodities is formulated as a Non-Linear Mixed Integer Program based on Stackelberg game. By adding auxiliary decision variables, the model is converted into a Mixed Integer Linear Program and solved by Cplex to verify its effectiveness. Numerical experiments and sensitive analysis are conducted to provide managerial insights of bundle sale strategy for multiple products. The reminder of this paper is organized as follows. In section 2, we describe the problem and propose the model as well as its converted formation. In section 3, numerical experiments and sensitive analysis are presented, and managerial implications are conducted. Finally, we state our conclusions in section 4.

2. Problem Definition and Modeling

This paper addresses the problem of composing and pricing bundles for multiple products. Consider a retailer faced with a problem of selecting and pricing a couple of bundles from a product line to be sold to a set of heterogeneous customers. The objective of the retailer is to maximize its profit while customers maximize their surplus. There are three main strategies offered by the company: (a) *individual selling*, which means the component products or services are sold as separate items; (b) *pure bundling*, when the component products or services are sold only as a bundle, and individual items are not provided. (3) *mixed bundling*, where both the bundle and the individual items are offered separately. We focus on the mixed bundling strategy because it is used widely in reality when multiple products are provided[4]. For example, the customer of Mc Donald can buy a single hamburger or a bundle consisting of hamburger, chips and cola.

2.1. Notations

- **Parameters**

J: Number of individual products;

j: Indices of individual products, and $j = 1,...,J$;

$P^0 = (p_1^0,...,p_j^0,...,p_J^0)$: the price of each individual product;

$C^0 = (c_1^0,...,c_j^0,...,c_J^0)$: the cost of each individual product;

I: The total number of all potential bundles;