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A multiobjective programming model for partner selection-perspectives of objective synergies and resource allocations

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ABSTRACT

Strategic alliances are widely used in business to obtain the synergy effect and competitive advantage. On the basis of the resource-based view, it can be seen that the valuable resources of firms provide the motivation for entering into strategic alliances. Therefore, the issue of partner selection plays a critical role in the performance of strategic alliances. Although many mathematical programming models have been proposed to deal with the partner selection problems, two main issues such as objective synergies and resource allocations are seems to be ignored. In this paper, a new multiobjective programming model is proposed to determine the optimal partners in the alliance and the corresponding resource allocations. Furthermore, a numerical example is used to demonstrate the proposed method and compared with the conventional method. From the results, it can be concluded that objective synergies and resource allocations play a significant role in the problem of partner selection and should not be ignored in the realistic alliance's problems.

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1. Introduction

The problem of partner selection is related to coalition formation that can be defined by a cooperative arrangement between two or more independent firms that exchange or share resources for competitive advantage. Since the 1980s, the problem of partner selection has been widely addressed in the contexts of strategic alliances (Auster, 1994; Harrigan & Newman, 1990; Porter & Fuller, 1986) and supply chain management (Garg, Narahari, & Viswanadham, 2006; Olhager & Selldin, 2004).

The essential motivation of partner selection can be described as "synergy effects" and be represented by using the following equation:

$$v(s^1 \cup \cdots \cup s^n) > \sum_{k=1}^{m} v(s^k) \tag{1}$$

where $v(\cdot)$ denotes the value/satisfaction function and s^k denotes the kth alliance partner. It can be seen that Eq. (1) can be interpreted as the value of alliance is larger than the summation of individual firms. Thus, when Eq. (1) is satisfied, alliance firms can share more value (e.g., profit, or market share) than their original states through coalition formation.

When some firms rush into alliances without appropriate preparation, i.e., decision making is under the situation that being lack of information to choose the correct partners and the way to allocate the corresponding resource, these alliances often fail (Dacin, Hitt, & Levitas, 1997). In fact, the questions above are usually complex and diversified, i.e. with the different firm's goals, culture, and resources, the best alliance partners and the corresponding resource allocations may be quite diverse.

In order to determine the correct partners for increasing competitive advantage, many mathematical programming models, such as linear programming (Anthony & Buffa, 1977; Pan, 1989), mixed-integer programming (Bendor, Brown, Issac, & Shapiro, 1985; Kasilingam & Lee, 1996), stochastic integer programming (Feng, Wang, & Wang, 2001), and goal programming (Buffa & Jackson, 1983; Karpak, Kumcu, & Kasuganti, 1999; Sharma et al., 1989), are widely employed. It can be seen that for a specific firm, by setting the appropriate objectives, the optimal alliance partners can be determined by solving the following multiobjective programming (MOP) model:

$$\max \quad f_1(\boldsymbol{x}) = f_1^e(x) + \sum_{i=1}^{m} s^i f_1^i(\boldsymbol{x})$$

$$\vdots$$

$$\max \quad f_n(\boldsymbol{x}) = f_n^e(x) + \sum_{i=1}^{m} s^i f_n^i(\boldsymbol{x})$$

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$$\text{s.t.}\quad g_j^e(\boldsymbol{x}) + \sum_{i=1}^{m} s^i g_j^i(\boldsymbol{x}) \leqslant b_j^e + s^i b_j^i,$$
$$\sum_{i=1}^{m} s^i = k, 1 \leqslant i \leqslant m; 1 \leqslant j \leqslant r, \quad \boldsymbol{x} \geqslant \boldsymbol{0} \tag{2}$$

where $f_j(\boldsymbol{x})$ denotes the jth objective of the alliance, $f_j^e(\boldsymbol{x})$ denotes the jth objective of the specific firm, $f_j^i(\boldsymbol{x})$ denotes the jth objective of the ith candidate partner, $s^i \in \{0, 1\}$ is a dummy variable, where 1 indicates the ith candidate partner is selected to be the partner, $g_j^e(\boldsymbol{x})$ and $g_j^i(\boldsymbol{x})$ denote the jth technological constraint of the specific firm and the ith candidate partner, respectively, b_j^e and b_j^i denote the jth limited resource of the specific firm and the ith candidate partner, respectively, and k denotes the number of alliance partners. Note that the "appropriate objectives" above may be quality, lead-time, profit, and customer satisfaction.

In spite of the mathematical programming model has been successfully employed to deal with various problems of partner selection, such as virtual Enterprise (Ip, Huang, Yung, & Wang, 2003), and international joint ventures (Hajidimitriou & Georgiou, 2002), two main issues, called objective synergies and resource allocations, should be highlighted so that the model above can deal well with the realistic problem of partner selection.

Objective synergies of the alliance can be defined by $\partial f_i(\boldsymbol{x})/\partial f_j(\boldsymbol{x}) > 0$ and can be interpreted as the objective levels of the jth alliance are positively related to the objective levels of the ith alliance. That is, when the value of the jth alliance' objective level increase, it will also trigger the value of objective level of the ith alliance increase. On the other hand, since the boundary of firms has be broken via alliance, the alliance's resources should be reallocated and rearranged for achieving the optimum. However, due to the restriction of objective independence and fixed limited resources in the traditional MOP model, the model above (Eq. (2)) cannot incorporate these two important issues, objective synergies and resource allocations, to select the correct partners and reallocate alliance's resources.

In this paper, a new multiobjective programming model is developed so that the objective synergies and resource allocations of the alliance can be considered to determine the correct alliance partners and the corresponding resource reallocations in this model. In addition, a numerical example is used to demonstrate the proposed method and compared with the conventional MOP method. On the basis of the results, it can be concluded that the objective synergies between alliances and the resource allocations of alliances are quite significant and should not be ignored in the problem of determining the optimal partner selection in alliances.

The reminder of this paper is organized as follows. Objective synergies and resource allocations in the problem of partner selection is discussed in Section 2. A new multiobjective programming is proposed in Section 3 to incorporate the issues of objective synergies and resource allocations in the partner selection problem. In Section 4, a numerical example is used to demonstrate the proposed method and compare with the conventional MOP model. Section 6 presents a discussion of the numerical example and conclusions are in the last section.

2. Objective synergies and resource allocations

In this section, the problems of objective synergies and resource allocations in alliance are highlighted in choosing the correct partners. First, to show the impact of objective synergies of the alliance, we can derive the optimal alliance partners by transforming Eq. (2) to the following compromise programming model (Yu, 1985):

$$\begin{aligned} \min \quad & r(\boldsymbol{y}; p) = \|\boldsymbol{y} - \boldsymbol{y}^*\|_p \\ \text{s.t.} \quad & g_j^e(\boldsymbol{x}) + \sum_{i=1}^{m} s^i g_j^i(\boldsymbol{x}) \leqslant b_j^e + s^i b_j^i \\ & \sum_{i=1}^{m} s^i = k, 1 \leqslant i \leqslant m; 1 \leqslant j \leqslant r, \quad \boldsymbol{x} \geqslant \boldsymbol{0} \end{aligned} \tag{3}$$

where $r(\boldsymbol{y}; p)$ is a measurement of regret from $\boldsymbol{y}$ to $\boldsymbol{y}^*$ according to the l_p-norm distance, $\boldsymbol{y}$ denotes the alliance's objective vector, and $\boldsymbol{y}^*$ denotes the alliance's ideal-point vector.

Assume a two-objective problem is considered to determine the optimal alliance partner problem and let $p = \infty$. Then the optimal partners can be obtained and the corresponding outcome space should be $\boldsymbol{y}^\infty$, as shown in Fig. 1, if and only if the two objectives are independent, i.e., $\partial f_1(\boldsymbol{x})/\partial f_2(\boldsymbol{x}) = 0$ and $\partial f_2(\boldsymbol{x})/\partial f_1(\boldsymbol{x}) = 0$. However, if the two objectives exist the effect of objective synergies (e.g., $\partial \hat{f}_2(\boldsymbol{x})/\partial f_1(\boldsymbol{x}) > 0$), the optimal partners may be changed and the corresponding outcome space transfers from $\boldsymbol{y}^\infty$ to $\hat{\boldsymbol{y}}_\infty$.

On the basis of Fig. 1, it can be seen that objective synergies of the alliance may dominate the problem of partner selection in the alliance and should not be ignored in the proposed model. In order to incorporate the concepts of objective synergies in choosing the optimal alliance partners, we can reformulate Eq. (2) as the following multiobjective programming model:

$$\begin{aligned} \max \quad & \hat{f}_1(\boldsymbol{x}) = f_1(\boldsymbol{x}) + \sum_{j=1, i\neq j}^{n} \alpha_{1j} f_j(\boldsymbol{x}) \\ & \vdots \\ \max \quad & \hat{f}_n(\boldsymbol{x}) = f_n(\boldsymbol{x}) + \sum_{j=1, i\neq j}^{n} \alpha_{nj} f_j(\boldsymbol{x}) \\ \text{s.t.} \quad & g_j^e(\boldsymbol{x}) + \sum_{i=1}^{m} s^i g_j^i(\boldsymbol{x}) \leqslant b_j^e + s^i b_j^i, \\ & \sum_{i=1}^{m} s^i = k, 1 \leqslant i \leqslant m; 1 \leqslant j \leqslant r; 0 \leqslant \alpha_{ij} \leqslant 1, \quad \boldsymbol{x} \geqslant \boldsymbol{0} \end{aligned} \tag{4}$$

where $\alpha_{ij} = \partial f_i(\boldsymbol{x})/\partial f_j(\boldsymbol{x})$ denotes the degree of interdependence (i.e. objective synergies) from the jth alliance objective to the ith alliance objective.

On the other hand, in order to highlight the problem of resource allocations in alliances, first to consider the resource allocation problem in a firm to solve the following knapsack problem:

$$\begin{aligned} \max \quad & f_1^e(\boldsymbol{x}) = c_{11}x_1 + c_{12}x_2 + \cdots + c_{1q}x_q \\ & \vdots \\ \max \quad & f_n^e(\boldsymbol{x}) = c_{n1}x_1 + c_{n2}x_2 + \cdots + c_{nq}x_q \\ \text{s.t.} \quad & g_j^e(\boldsymbol{x}) \leqslant b_j^e, 1 \leqslant i \leqslant m; 1 \leqslant j \leqslant r, \quad \boldsymbol{x} \geqslant \boldsymbol{0} \end{aligned} \tag{5}$$

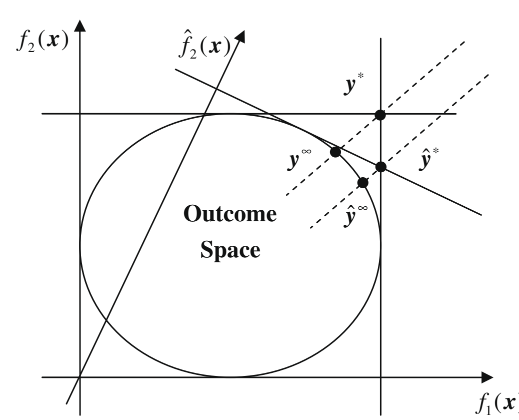

Fig. 1. The optimal solution between independent and interdependent objectives.

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