

Applying FMCDM to evaluate financial performance of domestic airlines in Taiwan

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Abstract

Many previous researches concerning the performance of airlines usually focus on operation. Financial performance, which would influence the survival of an airline, is often ignored. To evaluate financial performance, financial ratios obtained from balance sheet, income statement and cash flow must be partitioned into several clusters and found the representative indicators from these clusters to be criteria. In this paper, we utilize grey relation analysis to cluster financial ratios and find representative indicators. Then we apply a fuzzy multi-criteria decision-making (FMCDM) method to evaluate financial performance of airlines. Finally, an empirical study of financial performance of three domestic airlines in Taiwan is illustrated.

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Keywords: Airlines; Clustering; Grey relation; Financial performance; FMCDM

1. Introduction

For the deregulation of air transportation in 1987 and Asia financial crisis in 1997, the operation of an airline on air transportation market had been a challenge. Recently, the passenger or cargo load factor was decreased in Taiwan. The situation will be more worse gradually as high-speed rail is working. Therefore, the domestic airlines should enhance their performance. Based on the concept, the performance evaluation is important especially for the financial field. It is due to large capital being critical to these airlines. However, some previous researches concerning airline performance focus on the operation performance. Financial performance, which directly influences the survival of an airline, is often ignored. In fact, an airline should evaluate the financial performance to realize the financial location between these competitive companies.

In Taiwan, the main domestic airlines are Eva Air, China Airlines and Far Eastern Air Transport etc. To evaluate financial performance of these domestic airlines, we

must have evaluation criteria which are usually financial ratios (Walter & Robert, 1988). Financial ratios coming from balance sheet, income statement and cash flow in stock market are so many, whereas some of financial ratios are identified on similar patterns. To avoid evaluating on similar financial ratios repeatedly, financial ratios should be partitioned into several financial clusters, and a representative indicator is selected from one cluster to be as an evaluation criterion (Deogun, Kratsch, & Steiner, 1997; Dubes & Jains, 1988; Duda & Hart, 1973; Eom, 1999; Hirano, Sun, & Tsumoto, 2004; Kaufman & Rousseeuw, 1990; Krishnapuram & Keller, 1993; Lee, 1999; Miyamoto, 2003; Pedrycz & Vukovich, 2002). Then a fuzzy multi-criteria decision-making (FMCDM) method is applied to evaluate the financial performance of domestic airlines.

Based on these ideas, the representative indicators have to be found from financial ratios (Feng & Wang, 2000). We apply a clustering method to partition financial ratios into several clusters and select the representative ones from these clusters. From Taiwan stock market, we know that the number of major domestic airlines is merely 3, that is, Eva Air, China Airlines and Far Eastern Air Transport.

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The number is small and the distribution is unknown, thus these classical clustering methods such as cluster analysis, discriminant analysis, factor analysis and principal component analysis (Johnson & Wichern, 1992) are not suitable for the situation. To reflect the scarce data and unknown distribution, we utilize grey relation analysis (Deng, 1989) to partition financial ratios into several clusters and then find representative indicators from these clusters to be evaluation criteria. Because several evaluation criteria are found, the financial performance evaluation of airlines belongs to multi-criteria decision-making (MCDM) problems (Hwang & Yoon, 1981; Keeney & Raiffa, 1976). To illustrate MCDM, we will evaluate the financial performance of airlines from 2001 to 2005. Since these financial ratios of the 5 years are expressed with fuzzy numbers on calculation, the evaluation problem should be a FMCDM problem (Boender, de Graan, & Lootsma, 1989; Chang & Yeh, 2002; Chen, 2000; Chen & Hwang, 1992; Hsu & Chen, 1997; Jain, 1978; Liang, 1999; Ostrowski, O'Brien, & Gordon, 1993; Parasurman, Zeithaml, & Berry, 1985; Truitt & Haynes, 1994; Tsaour, Chang, & Yen, 2002; Wang, Lee, & Lin, 2003). In this paper, we apply the FMCDM method called fuzzy TOPSIS (Wang et al., 2003) to evaluate the financial performance of Taiwan domestic airlines. With the FMCDM method, the evaluation problem of financial performance can be easily solved.

For the sake of clarity, finding representative indicators with grey relation analysis are presented in Section 2. The notions of fuzzy sets and fuzzy numbers are introduced in Section 3. The FMCDM method is presented in Section 4. Finally, an empirical study of three domestic airlines in Taiwan is presented in Section 5.

2. Finding the representative indicators from financial ratios

In stock market, financial ratios are usually partitioned into some categories, because accounting experts suppose that the financial ratios in one category are partially similar. Thus the financial ratios of airlines are initially divided into four categories according to their related patterns. We review financial ratios of domestic airlines in Taiwan and present them as follows.

In Table 1, fixed assets to stockholder's equity ratio, debt to total assets ratio and accounts payable turnover belong to cost items, and the rest ratios belong to benefit items.

From Table 1, we evaluate the financial performance of domestic airlines in Taiwan based on these financial ratios. Since some of ratios have similar patterns, we apply grey relation analysis to partition them into several clusters and then find representative indicators to be evaluation criteria from these clusters. Grey theory was first introduced by Deng (1989). The fundamental definition of greyness is information being incomplete or unknown, thus an element from the incomplete message is taken as grey elements. Grey relation analysis is the method to measure the relations among the elements, and its definitions in mathematics and application to the clustering of financial ratios are stated as follows.

Assume that m airlines are evaluated on s financial ratios. Let $X_i = \{x_i(k)\} \in X$ denote the sequence of the financial ratio i , where $k = 1, 2, \dots, m$; $i = 1, 2, \dots, s$, and X is the set consisting of all financial ratio sequences. First, these financial ratios are divided into two situations to be normalized. If $x_i(k)$ belongs to benefit items, then

Table 1
The financial ratios on four categories

Category	Code	Formula	Ratio
Financial structure	F1	Fixed assets/total stockholder's equity	Fixed assets to stockholder's equity ratio
	F2	Fixed assets/long-term liabilities	Fixed assets to long-term liabilities ratio
	F3	Fixed assets/long-term capital	Fixed assets to long-term capital ratio
	F4	Total liabilities/total assets	Debt to total assets ratio
	F5	Total stockholder's equity/total liabilities	Stockholder's equity to total liabilities ratio
	F6	Working capital/total assets	Working capital to total assets ratio
Solvency	S1	Current assets/current liabilities	Current ratio
	S2	Quick assets/current liabilities	Quick ratio
	S3	Cash and cash equivalent/current assets	Cash ratio
	S4	Net cash provided by operating activities/current liabilities	Cash flow ratio
	S5	Working capital/current assets	Working capital to current assets ratio
Turnover	T1	Operation cost/accounts payable	Accounts payable turnover
	T2	Operation cost/accounts receivable	Accounts receivable turnover
	T3	Operation revenue/fixed assets	Fixed assets turnover
	T4	Operation revenue/total assets	Total assets turnover
	T5	Net income(loss)/operation revenue	Net income(loss) turnover
Profitability	P1	(Operation revenue – operation cost)/operation revenue	Gross profit ratio
	P2	Operation income(loss)/operation revenue	Operation profit ratio
	P3	Income(loss) before tax/operation revenue	Income before tax ratio
	P4	Net income(loss)/operation revenue	Net income ratio
	P5	Net income(loss)/total assets	Return on total assets

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