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Application of structural equation modelling for estimating airline performance

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ABSTRACT

Structural equation modelling (SEM) is an estimation method that can handle a large number of exogenous and endogenous factors as well as unobserved (latent) variables that are specified as linear combinations of observed (measurement) factors. This paper presents a SEM procedure with latent variables for estimating the financial and non-financial performance in airline companies. The model includes independent, mediator and dependent latent variables. The sample for this research comprises 214 airline companies. The results indicate that the model is capable of estimating performance with respect to the economic situation and it has also been determined that two types of constructs affect performance. One type is the economic situation acting as an initial construct and the other is the internal operation acting as the mediator in the research model.

1. Introduction

One of the most important results of globalisation has been the increase in the capacity and resources of airline companies, thus expanding the market areas, increasing destinations and business partners, and consequently, enhancing the conditions for increased competitiveness. Moreover, the survival of each company, especially during financial crises, depends on whether managers of the company can identify useful and potential ways to control and improve the company's performance given such a situation. Therefore, estimating and measuring company performance and the effective management of the company has constituted an important topic for studies in recent decades. The recognition of performance patterns of the airline organisation benefits managers in their role as decision makers by providing them a basis for making correct and effective decisions related to, for example, the timing of new interventions or the termination of existing change programmes during crisis situations.

To analyse the performance in the airline industry, different statistical methods such as ANOVA (Gilbert and Wong, 2003), time series (Lepak, 1997; Flouris and Swidler, 2004), regression (Clougherty and Zhang, 2009; Hung and Liu, 2005), the VaR model (Chuang et al., 2008; Guzhva and Pagiavlas, 2004), data envelopment analysis (Assaf and Josiassen, 2011; Barbot et al., 2008), the GARCH model (Chuang et al., 2006), the technique for order preference by similarity to ideal solution (TOPSIS) (Feng and Wang, 2000), fuzzy method (Liou and Tzeng, 2007; Shipley and Coy, 2009), multiple criteria decision making (Hsu and Liou, 2013) as well as structural equation modelling (Jenatabadi and Ismail, 2012) have been employed.

In recent years, SEM has attracted the attention of many researchers as a commonly adopted method used to analyse data with respect to numerous airline disciplines including low cost (Yang et al., 2012; Chiou and Chen, 2010), cabin safety (Hsu and Liu, 2012; Chang, 2012), customer loyalty (Forgas et al., 2012; Mikulić and Prebežac, 2011), traffic control (Kuo et al., 2012), job satisfaction (Ng et al., 2011; Chen and Kao, 2011) and performance (Martín-Consuegra and Esteban, 2007).

The main objective of this study is to introduce a triangular model to investigate the effect of the economic situation on airline performance, taking into consideration its internal operation, using SEM. Airline performance is measured with a combination of a few commonly used indicators. Unlike most previous research where each indicator is evaluated separately, this study introduces a latent variable to represent overall airline performance. The same approach is employed to define the economic situation and internal operation constructs. The results could be used by airline managers to answer the following two questions. Does the economic situation of a country affect the performance of that country's airline companies? While the answer is quite obvious, this analysis takes a

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different approach, thus providing the effect of a combination of economic indicators regarding overall performance and, hence, giving airline managers a clearer picture of the situation as they make decisions. Second, does the economic situation affect the overall internal operation and will it eventually affect the overall performance of the airline? Since managers have full control of the internal operation, they may be able to maintain their performance by maximising their internal operation during a poor economic situation. To answer these questions, we need a unified model provided by SEM to investigate the relationships among multiple dependent and independent variables.

2. SEM advantages and procedures

2.1. SEM advantages

2.1.1. Application of latent variables

Unobserved factors, variables, constructs and unmeasured variables are only some of the terms used to describe variables in the framework that do not exist in the data set, as "latent variables provide a degree of abstraction that permits us to describe relations among a class of events or variables that share something in common" (Bollen, 2002). Various studies with airline performance modelling use different indicators to estimate performance and present a separate model for each indicator performance. For example, Rajasekar and Fouts (2009) use RPMs, passenger load factor and market share as indicators; Oum and Zhang (2001) use total factor productivity, price, and profitability; and Aderamo (2010) use RPKs, aircraft kilometres and cargo ton kilometres. Airline performance models have demonstrated that there exists interrelationships between and among financial and non-financial indicators (Assaf, 2009). Based on the concept of a latent variable, we conclude that the airline performance construct, which is a combination of indicators such as RPK, load factor and profit, and the interdependent relationships among these factors, can be investigated using factor loading, another feature of SEM, to determine which of the variables are significant. As a result, with SEM we can present one model rather than multiple models with different dependent variables.

2.1.2. Consideration of direct and indirect effects

Economic indicators such as GDP, GDP per capita and inflation rates have been considered with other internal indicators as independent variables in previous research models. Some related literature is presented in Table 1. The modelling has the following structure.

(Internal Operation Indicators + Economic Indicators) → Performance

It is evident that if there is any economic change, managers attempt to change internal operations such as the number of flights, flight time and the block time to control the performance of the company. Accordingly, these economic indicators affect the internal operation, a concept that is not considered in most previous studies of airline performance modelling. The most significant of the SEM advantages is its ability to simultaneously model and show the indirect and direct interrelationships that exist among multiple dependent and independent variables (Gefen et al., 2000). Thus, SEM supports our objective to measure and estimate both direct and indirect effects in a single model with mediation analysis (see Fig. 1).

2.1.3. Other features of SEM in modelling

Another reason that SEM is the preferred model compared to methods of conventional multiple regressions is SEM's typically piecemeal nature to generate separate and individually distinct coefficients. The SEM technique permits checking and examining a complete model by generating goodness-of-fit statistics and assessing the overall fit (Ho, 2006). SEM also allows for the expansion of statistical estimation by assessing and estimating terms of error for observed variables. In the more traditional and conventional multivariate processes, such as multiple regression modelling, the error rate of variable measurement and the between variable residuals or their observed variables, i.e., indicators, are null (Pedhazur, 1997). However, this type of assumption is not necessarily realistic because the gauged variables usually have some degree of measurement errors, though it may be small. Consequently, biased coefficients are expected to result from the utilisation of the measurements, which is common in conventional multivariate methods. SEM enables the application terms of measurement error to the process of estimation, which ultimately contributes to the improvement of the reliability of the structural path coefficients (Chin, 1998).

Another feature of SEM that distinguishes it from other available models is its ability to allow the inclusion of both measurement and latent variables into the same analysis. As a result, the incorporation of these variables provides a stronger analysis of the suggested model and, thus, an improved evaluation (Chin, 1998; Gefen et al., 2000). Furthermore, SEM has the ability to assist in two other ways as it can handle complicated data (with non-normality and multicollinearity) and it can allow for the modelling of graphical interfaces (Garson, 2007).

Overall there are several important reasons as to why SEM is preferred over other available, more conservative multivariate methods. As a multiple regression model, SEM allows researchers

Table 1
Airline performance modelling with economic indicators.

Research	Economic indicators	Output (or dependent)	Method
Detzen et al. (2012)	GDP	Revenue passenger mile (RPM)	Regression
Lepak (1997)	Transformed monthly market stock prices	Transformed monthly airline stock prices	Time series
Jenatabadi and Ismail (2007)	Inflation rate, subsidy	Load factor	Regression
Chin and Tay (2001)	GDP	Profit	Regression
Dobruszkes and Van Hamme (2011)	GDP	Number of seats	Regression
Rey et al. (2011)	GDP per capita	Number of tourists	Panel data
Duval and Schiff (2011)	GDP	International visitor arrivals	Regression
Aderamo (2010)	GDP, inflation rate	RPK, aircraft kilometre, cargo ton kilometre	Regression

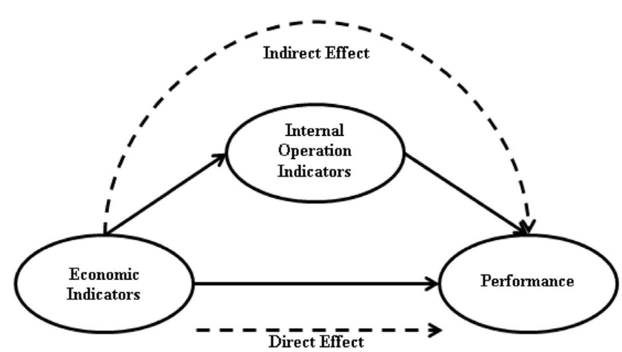

Fig. 1. Direct and indirect effect in SEM.