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IS THE LOW-COST STRATEGY OF LCC IN TAIWAN TRUE?

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Abstract

The establishment and rise of Low Cost Carrier (LCC) is a strategy of reducing costs. In this work, we have used the Grey prediction connotation model to establish a reasonable price measurement model and select the LCC routes in Taiwan for an empirical study. Firstly, it has been found that the LCC reasonable price measurement model constructed using the Grey prediction connotation model achieves accuracies above the qualified level, which verifies that the Grey prediction connotation model is able to provide a decision-making method for LCC managers to evaluate the reasonable prices. Secondly, the comparison between the reasonable fare price level of the LCC routes and the average price level allows the managers to determine whether the pricing strategy belongs to the high price or low price strategy. Finally, the LCC reasonable price measurement model can be used to know determine the proportion of the LCC routes that adopt the low price or high price strategy in the budget aviation market composed of LCCs, so that the managers will able to make follow-up decisions and rank the generated pricing. The research results from this study may provide a reference for airline managers in decision-making with respect to the price competitions.

Keywords: Low Cost Carriers (LCC), GM (1, 1) model, Grey prediction connotation model, reasonable prices

JEL: C60, M21, P22

1. INTRODUCTION

1.1. Research Background and Motives

Low cost carriers (LCCs) are airlines having low-costs, fair prices or budgets, also known as the No-frills or Budget Airlines (Sun, 2012). LCC's operating model is to use any strategy to reduce the costs and increase the passenger load factor under a competitive ticket price. To increase the market shares, these airlines utilize methods and strategies to improve the service quality, develop a complete route network and establish supporting measures for user feedback, in addition to reduce the operating costs, which is an important factor to be considered (Hassan, 2009), with the LCCs establishing low operating costs as the main operating strategy. The LCCs originated from Southwest Airlines in the United States. It is different from general airlines in that it focuses on the main consumers, omits on-board catering services and sets its airports outside the urban areas to reduce the total cost. As a result, it is able to provide cheaper fares than the general airlines and attract customers (Bozogá?, *et al.*, 2018).

With the gradual lifting of aviation control or liberalization in various countries, many LCC companies are being newly established. The existing LCC companies rapidly and many traditional full service carriers (FSC) have established LCC subsidiaries to extend their brands, counter the competitive threats from the LCCs and open the low- and middle-priced markets (Bozogá? *et al.*, 2018). Toh (2013) mentioned that the LCCs in Taiwan are up against the global market. With the improvement in economic growth and national income, the air transport industry has become an indispensable element in the society. It is necessary for the airlines to provide a safe, comfortable and speedy flight service under the consideration of lowered operating cost for sustainable operations and to meet the market demands whilst maintaining a high degree of competitiveness (Sun, 2012). Kwoka *et al.* (2016) proposed that the first factor considered by passengers when choosing an airline is the fare, which means that the LCCs will be more attractive to passengers if they can offer low prices in the fare policies and introduce preferential fares from time to time. Measkhan (2012) suggested that consumers' purchase intention is higher if their perception of the air tickets price is positive. In terms of the impacted prices, the low price is usually accepted.

Malighetti *et al.* (2013) proposed that when the passengers choose to spend money on airlines, the price perception is often the most important consideration for the passengers in choose an airline. If the consumers' perceived price is not satisfactory, they will have a relatively low purchase intention. Lordan (2014) also proposed that the price is the most important consideration for passengers to choose the LCCs. Nevertheless, many studies and related reports indicate that the LCCs are not cost-effective. For example, the LCC's landing at a secondary airport increases the passenger’s transportation costs and the extra charges for in-flight catering facilities, as well as the baggage weight restrictions make the total travelling costs similar to those of the FSC. The strategy behind the low price is to strip off the all-inclusive services of the FSC from the fare and let the passengers order them separately. If the passengers fail to understand the reality and choose the LCCs with the expectations of a FSC, then there will be a lot of controversy in the future (Hazledine, 2011). With the prosperity of leisure vacations, consumers have a growing demand for the aviation industry. Therefore, to maintain the competitiveness and profitability in the market, the airlines need to understand the importance of reasonable prices with respect to the consumers' purchasing power. The consumers' price perception has an impact on the purchase intention of airline tickets (Tan, 2018). Reasonable prices are the reference basis for consumer purchases. The managers need to research to understand the consumers' selection and the pricing of major competitive products (Whitecotton, 2014). Therefore, the motivation of this work lies in the imperativeness for LCC operation management to develop reasonable and low-cost pricing with low operating costs.

1.2. Research Purpose

Many unique and singular products' prices cannot be conferred by the conventional approach of cost-plus pricing. The pricing of unique route with cost information shortage primarily depends on the experience and subjective judgement of the managers. However, different experts may provide different estimates for the same product due to varying experiences and backgrounds. Sometimes the estimated prices are so different that reasonable pricing is a daunting task (Rao, 2011).

This study is based on the fact that the operation of LCCs in Taiwan is affected by many factors and there is no objective pricing method to follow. Therefore, I attempt to understand the operation of LCCs from literature considering low-cost strategies for operating costs and investigate the best reasonable price measurement method to construct a LCC. I also analyze 5 LCCs operating in Taiwan as the subjects for conducting our empirical research. The proposed research procedures are as follows:

1. Use the Grey prediction connotation model to construct a reasonable price measurement model for each LCC and test the accuracy of the model.
2. Estimate the reasonable price of each LCC's common route as given by the LCC reasonable price measurement model.

3. Compare the estimated reasonable price with the actual average price and analyze whether or not each the LCCs has adopted a low pricing strategy.

The results from this research can be used for LCC price measurement, prediction and analysis of reasonable prices, as well as reference for formulating fare decisions.

1.3. Research Methods and Framework

In this work, I first review relevant literature on aviation management and define the relationship between the aviation industry operating costs and aviation product fares. I further establish the research motivations and purposes of reasonable pricing decisions under given operating costs and target profits and summarize the relevant work. The Grey prediction connotation model is used to construct the pricing model and 5 LCCs in Taiwan are selected as examples for the empirical research. An applicable pricing method which considers reasonable prices with low operating costs of the LCCs is proposed. Finally, the proposed method is used as a reasonable price measure for the LCCs and compared with the current price difference analysis for making recommendations.

This paper is organized as follows. Section 1 describes the research background, motivations, purpose, methods and the framework of this paper. Section 2 provides the literature review, including the LCC aviation management overview, operating costs and price decisions and other related literature. Section 3 presents the quantitative method, including the Grey prediction theory and the establishment of forecasting quantity model. Section 4 lays out the empirical analysis, containing explanations of data collection and collation, empirical analysis and a summary of the empirical results. Finally, Section 5 summarizes the main research results and provides the conclusions.

2. LITERATURE REVIEW

2.1. Overview of the LCC Aviation Management

The LCC originated from Southwest Airlines in the United States. It is different from general airlines in that it targets short-distance travellers as its main consumer group, omits on-board catering services and situates its airports outside the urban areas to reduce the total cost of expenses, thereby providing a lower fare than general airlines to attract customers (Hassan, 2009). A LCC is defined as the operating strategy of an airline operating under the principle of simplicity and elicits cost savings for everything, with fewer cabin class choices to carry more low-cost passengers. A LCC usually uses a single type of aircraft to offers point-to-point direct flight services without in-flight meals, in-cabin entertainment facilities and services. All air tickets are booked via the Internet and telephone reservations and a large number of self-service check-in counter systems are used (Fageda *et al.*, 2011). The characteristics of the LCC operations can be discussed with respect to ticketing, aircraft operation and services. In terms of ticketing, a LCC may utilize dynamic fare strategies, online direct ticket sales, electronic tickets and free seating without fixed seat numbers. For aircraft operation, a LCC may provide secondary airport take-off and landing, point-to-point flight, single fleet, increased aircraft utilization and non-core business outsourcing. With regard to the services, a LCC may not provide free meals on board, VIP rooms, or cumulative flight mileage rewards plan. It may only provide economy class with narrow seat spacing, low labor costs and high work efficiency. As a whole, a LCC's operating model is to use any strategy to reduce the expenditure so that its airline tickets will have the competitive price advantages (Ros, 2011).

The difference between a LCC and a FSC lies in that behind the low air ticket prices, a LCC only provides the basic transportation responsibilities and obligations between the source and the destination. Apart from the regulatory and necessary items for flight safety, supplementary services are charged in addition to the fare. It is difficult for a LCC to meet the passengers' high quality requirements, as given by the 4S concept: service, scale, space and speed (Bozogá? *et al.*, 2018). For most airlines, in addition to the improvement of the service quality, the development of a complete route network, the establishment of member feedback supporting measures and the reduction in operating costs are all important factors considered in the strategies to increase their market shares, whereas a LCC airline's main operating strategy is to lower the operating costs.

2.2. A LCC's Operating Cost and Price Decision

The operating costs of airlines mainly include the straight-line staff costs (salary, insurance, food, travel, traineeship and others), aircraft maintenance costs (costs for maintenance and spare parts), aircraft insurance costs and indemnity costs, fuel consumption costs (costs for aircraft fuel and lubricants), material costs, business repair costs (costs for administrative departments and agencies engaged in operation, management and development, as well as other relevant costs, including management staff salaries, costs associated with office space, work, business and so on). Sun (2012) observed the management of airlines' operating costs. The global air transport industry is facing a trend of rising fuel costs and carbon offsets are imperative for environmental protection. Airlines must make trade-offs between saving costs on existing routes and reducing the environmental costs. The reduction of operating costs is a way for airlines to have more management benefits. Target cost pricing can minimize costs and calculate the maximum profit when the number of passengers is known. This is consistent with a LCC's financial performance goals (Kwoka *et al.*, 2016).

Considering a LCC's operating characteristics, the key to success is to ensure the safety of the flight and to increase the profits by reducing the costs. Information technology plays a key role in operating cost management, especially in the precise control of each link's cost and the data analysis of passenger behaviors. Furthermore, effective online sales and revenue management systems can also be implemented with relatively low costs, so that more competitive prices can be launched in the market. The ticket price affect the income and profitability of a LCC, which in turn affects the value of the LCC (Malighetti, *et al.*, 2013). Tan (2018) believes the assumption that all of the LCCs have the same service technology and with fixed marginal operating costs. The pricing is set so that the consumer's reserve price is greater than the market price, which is in turn higher than the marginal operating cost. A LCC should implement an appropriate pricing strategy taking into account the substantial reductions in the operating costs and non-essential costs to make the LCC companies more competitive (Hazledine, 2011). Lordan, (2014) has observed that the price is the most important consideration for passengers when choosing the service of a LCC. Nevertheless, many studies and related reports have found that the LCCs are not cheaper, as the total cost of choosing the LCC, which includes the costs incurred by landing at a secondary airport and increases the passenger transportation costs, the extra charges for in-flight catering facilities and charges due to restricted baggage weight, may accumulate to an amount similar to the cost of a traditional FSC.

3. QUANTITATIVE METHOD

3.1. Grey Prediction Theory

Management accounting information is used to provide decision-makers with information relevant to the current and future decisions in decision-making, and it must rely on reliable and accurate quantitative prediction methodology (Wang, 2017). The Grey prediction theory is one of the quantitative prediction methods. The Grey system theory was proposed by Julong Deng in 1982 to circumvent the requirement of probability statistics which involves a large number of samples. It explains how to provide an efficient research method system under the ambiguity of the system model and data incompleteness to perform relational analysis and model construction on the system. It also uses prediction and decision-making methods to explore and understand the system, and deal effectively with system uncertainties, multivariable input, discrete data and data incompleteness. Basically, the Grey system theory analysis can be divided into Grey generating, Grey relational analysis, Grey modeling, Grey prediction, Grey decision and Grey control (Deng, 2000).

Grey prediction generally refers to the GM (1,1) model, including the source model, and the connotation model deduced, mapped and derived from the source model. In the comparison of prediction quantitative methods such as regression analysis, time series method and neural network model, the advantages of the regression analysis method is that it has a minimum data requirement of 10 or more than 20, the data state is the same trend and regular, with a theoretical basis to explain the relationship of the model, the change of the variables can be effectively analyzed and explained, and the elasticity analysis of variables and the estimation of the confidence interval of prediction results can be carried out (Tseng *et al.*, 1996). The disadvantages of the regression analysis include a fixed coefficient model, the lack of flexibility to reflect external factors, the requirement of a large amount of data, and the limited function types of either linear, exponent or logarithm functions. The minimum data required by the time series method is more than two peak values, and the data should be the same trend, regular and self-adjusting. The advantages of the time series method include periodic, seasonal, cyclic and irregular trends, easy data collection at low cost, as well as real long-term effects, and it is easy to explain why the effects appear discontinuous. However, it lacks theoretical basis and both its models and the explanation are difficult, so a high degree of skill and experience is required for the selection of the model (Pale and Larry, 1993).

The minimum data required for the Grey prediction method is 4, both equidistant and unequal intervals are applicable. Its advantages include the need of only 4 original data to make predictions and there is no need to make prior assumptions regarding the distribution of the variable sequence before modeling. The model is simple to operate and its prediction accuracy is high. The prediction difference is smaller with a small number of samples, and it can be used for short-term, medium-term or long-term predictions. It can be used instead of traditional models that require a large number of observations to make various predictions. The current LCC price statistics are usually not complete after the month of consumption. This study uses the Grey prediction whitening connotation model for model construction and is able to achieve average model accuracies of more than 70% (Deng, 2000) in the measurement of reasonable LCC prices.

3.2. Establishment of Prediction Quantity Model

The construction of the Grey prediction theory model involves the symbols defined as follows:

a : Grey prediction GM (1,1) model development coefficient.

μ : Grey prediction GM (1,1) model specific parameters.

δ : Grey prediction GM (1,1) model error value.

C_G : Grey prediction GM (1,1) model accuracy.

$\hat{X}^{(0)}(k)$: The predicted value of the measurement variable in the th period obtained by Grey prediction GM (1,1) model.

$X^{(0)}$: The actual value of the measurement variable during the study period.

n : The original number of measurement variables during the study period.

$P_{i,k}$: Reasonable price for the ith LCC in the th period.

From the Grey prediction methodology and the LCC management reference, the research assumptions are as follows:

1. 4 or more variables of the original data used to construct the prediction model can be used for model construction of the prediction model.
2. According to the Grey theory, it is not necessary to assume the distribution of the variable sequence before modeling.
3. Since the LCC route prices are based on the original value of the open route day of a certain period, the value used to measure the level of economic contribution has the characteristics of equal spacing.

4. When the average accuracy of the Grey prediction GM(1,1) model and the whitening connotation mode is greater than 70%, it means that the prediction mode is applicable.

When a large sample of the numerical values of reasonable price is not available, the Grey theory is able to provide high-quality prediction with a small number of modeling samples (Deng, 2000). The following explains the use of Grey prediction GM (1,1) and the whitening connotation model in the construction of a reasonable price prediction model. First, the original sequence of price values is defined according to the first-order differential equation of the GM (1, 1) model as:

$$\frac{dX^{(1)}}{dk} + aX^{(1)} = u, \tag{1}$$

where k is the independent variable of the system, a is the development coefficient and is the Grey control variable with a and u being the specific parameters of the model. Suppose the original sequence of the prices, $X^{(0)}$, is:

$$X^{(0)} = \{X^{(0)}(1), X^{(0)}(2), ..., X^{(0)}(n)\}. \tag{2}$$

With the Grey system modeling, it is necessary to first perform an accumulated generating operation (AGO) on the original sequence of prices, $X^{(0)}$, to provide intermediate information for modeling and weaken the randomness of the original sequence. Define the price value, $X(1)$, as the AGO sequence of the measurement variable, $X^{(0)}$, namely

$$X^{(1)} = \{X^{(1)}(1), X^{(1)}(2), ..., X^{(1)}(n)\}, \tag{3}$$

where

$$X^{(1)}(k) + \sum_{i=1}^{k} X^{(0)}(i), \ \ k = 1, 2, ..., n.$$

By Eqs. (2) and (3), and the least square method, the coefficient, $\hat{a}$, is calculated as

$$\hat{a} = (a, u)^T. \tag{4}$$

Substitute the obtained coefficient, $\hat{a}$, into the differential equation to solve Eq. (2) and the approximate relationship is obtained as

$$\hat{X}^{(1)}(k+1) = (X^{(0)}(1) - \frac{u}{a})e^{-ak} + \frac{u}{a}, \quad (5)$$

where the price, $\hat{X}^{(0)}(1)$, is equal to, $X^{(0)}(1)$. By making an inverse accumulated generating operation (IAGO) on Eq. (5), the value of the price sequence to be restored, $\hat{X}^{(0)}(k)$, can be obtained as

$$X^{(0)}(k) = \left[X^{(0)}(1) - \frac{u}{a}\right]e^{-a(k-1)}(1-e^{a}) \quad (6)$$

Let k = 1, 2, ..., n, the value sequence of the restored price, $\hat{X}^{(0)}$, is

$$\hat{X}^{(0)} = (\hat{X}^{(0)}(1), \hat{X}^{(0)}(2), ..., \hat{X}^{(0)}(n)). \quad (7)$$

The whitening connotation model is derived from the original model of the Grey prediction GM (1,1) model, which reduces the scattered information of the original model to achieve the purpose of homogenization. Under the original LCC price Grey prediction GM (1,1) model, the LCC reasonable price connotation prediction model is:

$$\hat{X}^{(0)}(k) = \left(\frac{1-0.5a}{1+0.5a}\right)^{k-2} \frac{\mu - aX^{(0)}(1)}{1+0.5a}. \quad (8)$$

Therefore Eq. (8) is the established GM (1,1) model of the LCC price Grey prediction, and Eq. (8) can be the target reasonable price prediction value. After the above model generation and construction, it must be further tested for accuracy to understand the error, , between the LCC price prediction value and the actual value. In this paper, the residual test method is used to compare the residual value according to the actual value and the predicted value. The formula is as follows

$$\delta(k) = \left|\frac{X^{(0)}(k) - \hat{X}^{(0)}(k)}{X^{(0)}(k)}\right| \times 100\% \quad (9)$$

The accuracy index, C_G is

$$C_G = 1 - \delta(k). \quad (10)$$

When the average accuracy is greater than 70%, it indicates that the prediction performance of the reasonable price the Grey prediction connotation model is qualified and applicable.

4. EMPIRICAL RESEARCH

This study mainly uses the Grey prediction connotation model to measure the reasonable price of the LCC. In this section, an empirical study is carried out to explain the collection and collation of data, empirical analysis and to provide a summary of the empirical results.

4.1. Data Collection and Collation

The main LCCs in Taiwan include Scoot, Vanilla Air, Jetstar Airways, Tigerair Taiwan, and Peach Aviation. This study has selected the above 5 LCCs as research subjects, and collected the fare information of each route used for modeling from the LCCs' webpages. As the routes provided by each LCC are different, the common routes were used in a comparative analysis of whether they are in line with the low-cost pricing strategy. The common routes included Taipei to Tokyo, Tokyo to Taipei, Taipei to Sapporo, Sapporo to Taipei, Taipei to Bangkok and Bangkok to Taipei, and an original pricing list of the LCC routes was constructed. Since the LCC route fare information disclosed is the figure for the next month and close to the completion date of the study, October 2018 was taken as the study period. Using the model to explore the LCC route from Taipei to Tokyo as an example, 180 seats at the same level from the five selected LCCs were considered for the pricing decision analysis during the study period. The price data of each company is compiled in Table 1, and the other routes follow similar rules.

Table 1: Taipei to Tokyo 108-seat LCC Price List (n= 30)

Unit: NTD

k	*Date Month/day*	*Scoot (TR898)*	*Vanilla Air (JW100)*	*Jetstar Airways (GK12)*	*Tigerair Taiwan (IT200)*	*Peach Aviation (MM858)*
0	10/01	3,638	4,698	4,398	4,149	4,650
1	10/02	3,638	4,698	4,398	3,549	4,320
2	10/03	2,783	4,298	2,198	4,149	3,990
⋮	⋮	⋮	⋮	⋮	⋮	⋮
28	10/29	2,738	3,498	2,498	3,849	3,990
29	10/30	3,138	3,498	2,498	3,849	3,490

4.2. Empirical Analysis

In this section, the empirical analysis of each route is carried out, using the quantitative method in the operation steps of (1) to (8), and summarizing the quantity structure of each route's reasonable price. The Taipei-Tokyo GM (1,1) connotation model analysis and the reasonable price Grey model analysis for each LCC's Taipei-Tokyo route for 108 seats are listed in Table 2.

Table 2: Grey Model Analysis of Taipei to Tokyo 108-seat LCC Price

Variable	*Scoot (TR898)*	*Vanilla Air (JW100)*	*Jetstar Airways (GK12)*	*Tigerair Taiwan (IT200)*	*Peach Aviation (MM858)*
a	0.0029	0.0159	0.0087	0.0079	0.0058
μ	3928.4451	4895.4913	3455.0912	5440.3092	5253.9621
$\left(\frac{1-0.5a}{1+0.5a}\right)$	0.9971	0.9842	0.9913	0.9921	0.9942
$X^{(0)}(1)$	3638	4698	4398	4149	4650
$\left[\frac{\mu-aX^{(0)}(1)}{1+0.5a}\right]$	3912.2896	4782.6353	3401.7743	5386.2239	5212.0681

Using the values in Table 2, we can define the GM (1,1) connotation model of the LCC reasonable price measurement model, calculate the accuracy of the model, measure the possible pricing when k is 31 periods, and compare the average pricing during the study period to understand whether or not the LCC adopts a low price strategy. Related analysis is organized in Table 3. By Eq. (8), the price measurement model of GM (1,1) connotation model is

$$\hat{X}^{(0)}(k)=\left(\frac{1-0.5a}{1+0.5a}\right)^{(k-2)}\times\frac{b-aX^{(0)}(1)}{1+0.5a}.$$

Taking Scoot (TR898) as an example, from Table 3, it is known that

$$\frac{1-0.5a}{1+0.5a}=0.9971$$

and

$$\frac{\mu-aX^{(0)}(1)}{1+0.5a}=3912.2896.$$

Then Scoot (TR898) can be modeled by the GM (1, 1) connotation model to construct the price measurement model as follows

$$\hat{X}^{(0)}(k) = (0.9971)^{(k-2)} \times 3912.2896. \tag{11}$$

The other four companies can be modeled in the same way. Using Eq. (11), we can measure the price level of Scoot (TR898) in each period of October 2018, and use Eqs. (9) and (10) to perform a reliability test with the actual price. If the average accuracy, C_G, is greater than or equal to 90%, it means that the measurement model has an excellent level of reliability, between 80-90% indicates a good level of reliability, between 70-80% indicates a passing level of reliability, and less than 70% is unqualified. The analysis of Scoot (TR898) as an example shows that the average C_G is 77.79%, which belongs to the passing level. The same analysis has been performed for the other four companies to obtain the average C_G of each measurement model and the reliability level of the model. If the measurement model is within the passing level, it can be used to determine the new LCC price when the period k is 30. Taking Scoot (TR898) as an example with $k = 30$ and substituting it into Eq. (11) to obtain the value of 3,597 for $\hat{X}^{(0)}(30)$. The obtained price of NTD 3,597 is compared to the average price of NTD 3,754 during the October 2018 study period. From the comparison, Scoot (TR898) is expected to have a low price strategy. The same analysis is performed for the other companies as well.

Table 3: Taipei to Tokyo 108-seat LCC Price Measurement Model Analysis

Variable	$\hat{X}^{(0)}(k)$	*Average* C_G	$\hat{X}^{(0)}(30)$	*Average Price*	*Difference*
Scoot (TR898)	$(0.9971)^{(k-2)} \times 3912.2896$	77.79% (Pass)	3,597	3,754	Low
Vanilla Air (JW100)	$(0.9842)^{(k-2)} \times 4782.6353$	89.07% (Good)	3,014	3,891	Low
Jetstar Airways (GK12)	$(0.9913)^{(k-2)} \times 3401.7743$	81.12% (Good)	2,639	3,064	Low
Tigerair Taiwan (IT200)	$(0.9921)^{(k-2)} \times 5386.2239$	85.22% (Good)	4,282	4,809	Low
Peach Aviation (MM858)	$(0.9942)^{(k-2)} \times 5212.0681$	84.50% (Good)	4,408	4,807	Low

The GM(1,1) connotation model analyses for Tokyo-Taipei, Taipei-Sapporo, Sapporo-Taipei, Taipei-Bangkok and Bangkok-Taipei have similarly results. The reasonable price modeling of the connotation model for each of the LCCs' common route, the accuracy test, the prediction measurement, the analysis logic of measuring the comparison with the high and low prices, the analysis of the route from Taipei to Tokyo, and the final LCC price measurement model analysis table are organized in Tables 4 to 8.

Table 4: Tokyo to Taipei 108-seat LCC Price Measurement Model Analysis

Variable	$\hat{X}^{(0)}(k)$	*Average*	$\hat{X}^{(0)}(30)$	*Average*	*Difference*
Scoot (TR899)	$(0.9971)^{(k-2)} \times 3912.2896$	77.79% (Pass)	3,597	3,754	Low
Vanilla Air (JW101)	$(0.9941)^{(k-2)} \times 4881.1859$	85.46% (Good)	4,112	4,520	Low
Jetstar Airways (GK203)	$(0.7043)^{(k-2)} \times 6084.3467$	70.43% (Pass)	6,138	6,235	Low
Tigerair Taiwan (IT201)	$(0.9947)^{(k-2)} \times 5307.6913$	84.78% (Good)	4,546	4,901	Low
Peach Aviation (MM859)	$(0.9884)^{(k-2)} \times 6029.4538$	72.48% (Pass)	4,295	5,126	Low

Table 5: Taipei to Sapporo 108-seat LCC Price Measurement Model Analysis

Variable	$\hat{X}^{(0)}(k)$	*Average*	$\hat{X}^{(0)}(30)$	*Average*	*Difference*
Scoot (TR892)	$(0.9991)^{(k-2)} \times 4792.1388$	90.57% (Excellent)	4,680	4,738	Low
Vanilla Air (JW100)	$(0.9822)^{(k-2)} \times 4948.3703$	88.33% (Good)	2,943	3,958	Low
Jetstar Airways (GK12)	$(0.9909)^{(k-2)} \times 5865.7711$	84.35% (Good)	4,219	5,171	Low
Tigerair Taiwan (IT236)	$(0.9921)^{(k-2)} \times 8183.5381$	83.46% (Good)	6,503	7,289	Low
Peach Aviation (MM726)	$(0.9797)^{(k-2)} \times 6987.8521$	81.72% (Good)	3,850	5,307	Low

Table 6: Sapporo to Taipei 108-seat LCC Price Measurement Model Analysis

Variable	$\hat{X}^{(0)}(k)$	*Average*	$\hat{X}^{(0)}(30)$	*Average*	*Difference*
Scoot (TR893)	$(0.0147)^{(k-2)} \times 3030.0404$	76.48% (Pass)	4,637	3,705	High
Vanilla Air (JW900)	$(0.9834)^{(k-2)} \times 3520.2937$	83.80% (Good)	2,166	2,874	Low
Jetstar Airways (GK106)	$(0.9949)^{(k-2)} \times 5990.4804$	84.35% (Good)	5,539	5,171	High
Tigerair Taiwan (IT237)	$(0.0004)^{(k-2)} \times 5017.0322$	82.47% (Good)	4,947	4,955	Low
Peach Aviation (MM725)	$(2.7643)^{(k-2)} \times 4741.2681$	85.81% (Good)	4,745	4,726	High

Table 7: Taipei to Bangkok 108-seat LCC Price Measurement Model Analysis

Variable	$\hat{X}^{(0)}(k)$	*Average*	$\hat{X}^{(0)}(30)$	*Average*	*Difference*
Scoot (XW181)	$(1.0002)^{(k-2)} \times 4220.3289$	89.31% (Good)	4,255	4,195	High
Jetstar Airways (3K722)	$(0.9968)^{(k-2)} \times 5378.2861$	82.28% (Good)	3,968	5,105	Low
Tigerair Taiwan (IT505)	$(0.9962)^{(k-2)}) \times 5365.9189$	90.40% (Excellent)	4,801	5,038	Low

Table 8: Bangkok to Taipei 108-seat LCC Price Measurement Model Analysis

Variable	$\hat{X}^{(0)}(k)$	*Average*	$\hat{X}^{(0)}(30)$	*Average*	*Difference*
Scoot (XW182)	$(1.0016)^{(k-2)} \times 4065.2281$	89.26% (Good)	4,269	4,125	High
Jetstar Airways (3K516)	$(0.9976)^{(k-2)} \times 5869.8333$	86.54% (Good)	5,625	5,487	High
Tigerair Taiwan (IT506)	$(0.9923)^{(k-2)} \times 5893.5206$	91.57% (Excellent)	4,712	5,308	Low

4.3. Empirical Results

According to the literature review, the LCC's operating strategy is based on a low operating cost strategy. To this goal, the low price strategy should follow the reasonable price measurement method. Therefore, the five LCC common routes in Taiwan were used as research subjects, and the empirical analysis of pricing was performed for a total of 26 routes, including 5 common routes from Taipei to Tokyo, 5 common routes from Tokyo to Taipei, 5 common routes from Taipei to Sapporo, 5 common routes from Sapporo to Taipei, 3 common routes from Taipei to Bangkok and 3 common routes from Bangkok to Taipei. Based on the purpose of this study, the following empirical results are summarized:

1. Using the Grey prediction connotation model for model construction and accuracy test:
    (1) For the reasonable price measurement model of each LCC route, there are 3 routes with excellent accuracies of greater than 90%, namely Scoot's Taipei to Sapporo route, Tigerair Taiwan's Taipei to Bangkok route, and Tigerair Taiwan's Bangkok to Taipei route.
    (2) For reasonable price measurement model for each LCC route, there are 5 routes with the accuracies below 80% but higher than 70%, which fall into the passing level, namely Scoot's Taipei to Tokyo route, Scoot, Jetstar Airways and Peach Aviation's Tokyo to Taipei route, and Scoot's Sapporo to Taipei route.
    (3) Except for the above-mentioned total of 8 excellent and passing routes, the remaining 18 routes all have accuracies of less than 90% but greater than 80%, falling into the good level.
    (4) According to the accuracy of the reasonable price measurement model of each route, the accuracy level of the model is 81%. This demonstrates that the Grey prediction connotation model is applicable in producing the reasonable price measurement model for the LCC routes.
2. The measurement of the reasonable price for each LCC route:
    (1) The analysis of Scoot's 6 routes shows that the routes of Taipei to Tokyo, Tokyo to Taipei and Taipei to Sapporo are underpriced, and the routes of Sapporo to Taipei, Taipei to Bangkok and Bangkok to Taipei are overpriced.
    (2) The analysis of Vanilla Air's 4 routes shows the route between Taipei and Bangkok is suspended and all prices are low.
    (3) The analysis of Jetstar Airways' 6 routes shows that apart from Sapporo to Taipei and Bangkok to Taipei, the remaining 4 routes are underpriced.

(4) Tigerair Taiwan's 6-route analysis shows that all prices are low.

(5) The analysis of Peach Aviation's 4 routes shows that the route between Taipei and Bangkok is closed, and except for the Sapporo to Taipei route, the remaining 4 routes are underpriced.

(6) It can be observed from the above analyses on LCCs that when a reasonable price measurement model is used to analyze the recent consumption date (when k is 30), most of the LCCs adopt a low price strategy.

3. Reasonable price measurement of 26 LCC routes:

(1) The pricing is higher in terms of the strategic response for only 6 routes close to the consumption date (when k is 30), which are Scoot's 3 routes including Sapporo to Taipei, Jetstar Airways' 2 routes of Sapporo to Taipei and Bangkok to Taipei, and Peach Aviation's route of Sapporo to Taipei. The remaining 20 routes are all underpriced.

(2) When 76.92% of the routes have low pricing response, it shows that the LCC adopts a low price strategy in the competitive low-cost aviation market.

The pilots and those who work on an aircraft have a maximum daily flight limit, the LCCs introduce the so-call "four hours" advantage law, that is, a two-way, return flight time of 4 hours or a one-way flight of 8 hours. Owing to this law, Taiwan has become one of the most important relay destinations for the LCCs in the Northeast and Southeast Asia, especially for Singapore, Kuala Lumpur, Osaka, Tokyo and Seoul, which are about 3 to 4 hours flight time from Taiwan Taoyuan Airport. Note that the low-pricing strategy adopted by the LCCs to increase the operating income are different to the strategies adopted by the non-LCCs.

5. CONCLUSION

As the leisure and holiday trend becomes popular in Taiwan, the consumers' demand for the aviation industry also increases. Consequently, the air transport companies need to understand the factors influencing the consumers' purchasing power to predict the actual purchase behaviors of the consumers and formulate reasonable prices to maintain their competitiveness and profitability within the market. Price perception is one of the major considerations for most consumers when making purchase decisions and can impact the consumers' airline ticket purchase intentions. Reasonable price is the basis for the consumers' purchase.

In particular, the optimally low pricing made by the LCC managers while minimizing the operating cost is an important issue for the LCC operation management.

This study was based on the relevant literature review of aviation management to define the relationship between the LCC operating costs and airline product fares, establish the research motivation and purpose of optimal pricing decisions at low operating costs, and establish a reasonable price measurement model based on the Grey prediction connotation model. The LCC route in Taiwan were selected for an empirical study, and the main research results are summarized as follows.

1. In terms of adopting the Grey prediction connotation model to construct the LCC reasonable price measurement model, the accuracy is above the passing level, and a large proportion of the results are within the good level. It is has been verified that the Grey prediction connotation model can be used to predict pricing, and to provide the LCC managers with the decision-making method to evaluate reasonable prices.
2. The LCC fare reasonable price measurement model modeled by the Grey prediction connotation model is used to provide the reasonable price measurement and the accuracy test of each LCC route and evaluate the reasonable price level of the LCC route. After comparing it with the average actual price level, the manager can deduce whether the pricing orientation is a high price or low price strategy.
3. The LCC fare reasonable price measurement model constructed by the Grey prediction connotation model is able to determine the proportion of the LCC routes that adopt a low or high pricing strategy in the low-cost airline market composed of LCCs. It can assist the managers to decide whether or not to follow the strategies and perceive the pricing level.

In earlier instances, companies or households produce products for sale to create profits. The value of the transactions is the price of the products. Cost accounting provides cost information to sellers in the determination of prices. The research results in this study provide a reference for managers to consider the operating costs, plan for target profits or make price competition strategies in the airline industry. There are also applications for the other industries. For example, many cultural and creative products are new to the market with limited or no accumulative historical cost information, leading to difficult objective pricing. The proposed approaches in this work can be used to apply the Grey system theory to construct pricing models that are useful for art pricing.

References

Bozogáò, M., Hurná, S. and Acta, L. (2018). "Differences between Low-cost Model and Full-service Model in Air Industry", *Semsa*, 5(4), 115-119.

Deng, J.L. (2000). *The Theory and Application of Grey System*, Taipei: Chnan Wa Co, Ltd, 2000.

Fageda, X., Jimenez, J. L. and Perdiguero, J. (2011). "Price rivalry in airline markets: a study of a successful strategy of a network carrier against a low-cost carrier", *Journal of Transport Geography*, 19(4), 658-669.

Hassan, A. E. (2009). *A modeling framework for airlines competition analysis: Application to the U.S. domestic network*, Southern Methodist University, United States: Country of publication.

Hazledine, T. (2011). "Legacy carriers fight back: Pricing and product differentiation in modern airline marketing", *Journal of Air Transport Management*, 17(2), 129-134.

Kwoka, J., Hearle, K. and Alepin, P. (2016). "From the Fringe to the Forefront: Low Cost Carriers and Airline Price Determination", *Review of Industrial Organization*, 48(3), 247-268.

Lordan, O. (2014). "Study of the full-service and low-cost carriers network configuration", *Journal of Industrial Engineering and Management*, 7(5), 1112-1123.

Malighetti, P., Stefano, P. and Redondi, R. (2013). "The Low-cost fare response to new entry", *European Transport Research Review*, 5(4), 185-194.

Measkhan, T. K. (2012). *Essays on Strategic Behavior in the U.S. Airline Industry*, The Ohio State University, United States: ProQuest Dissertations Publishing.

Pale, G. B. and Larry, C. P. (1993). *Business Fluctuations: Forecasting Techniques and Applications* (2nd ed.), Prentice-Hall, Inc., New Jersey.

Ros, A. J. (2011). "The Determinants of Pricing in the Mexican Domestic Airline Sector: The Impact of Competition and Airport Congestion", *Review of Industrial Organization*, 38(1), 43-60.

Sun, J. Y. (2012). *A Study of the Effects of Korean Airline Deregulation: The Impact of Low Cost Carriers (LCCs) Entry on Air Travel Demand and Welfare Gains*, Cornell University, United States: Country of publication.

Tan, K. M. (2018). "Outsourcing and Price Competition: An Empirical Analysis of the Partnerships between Legacy Carriers and Regional Airlines", *Review of Industrial Organization*, 53(2), 275-294.

Toh, M. (2013). "Taiwan's airlines mull budget carrier Airline", *Business London*, 29(5), 20.

Tseng, K. H., Tsaur, S. H. and Chiang, C. Y. (1996). "The Comparison of Four Kinds of Prediction Methods: Traditional Econometric Regression, Fuzzy Linear Regression, GMDH, and Artificial Neural Network—An Example of the Demand Forecast of the Taiwanese Tourists to Hong Kong", *Journal of the Chinese Statistical Association*, 24(2), 132-161.

Rao, S. K. (2011). "Pricing Biologics: Issues, Strategic Priorities and a Conceptual Model", *Journal of Commercial Biotechnology*, 17 (1), 7-23.

Wang, Y. H. (2017). *Cost and Management Accounting,* Taipei: San Min Books.

Whitecotton, S., Libby, R. and Phillips, F. (2014). *Managerial Accounting*, New York: The McGraw-Hill Companies, Inc.