Research on route selection strategy of low-cost airlines

Mingxing Kong[1], Shengrun Zhang[1*], Jinfu Zhu[1], Yao Zhao[2] and Aijing Su[1]

[1] College of Civil Aviation, Nanjing University of Aeronautics and Astronautics, Nanjing, Jiangsu, 210016, China

[2]ZHEJIANG LOONG AIRLINES CO., LTD.,Hangzhou,Zhejiang,, 311200, China

*Email: 273396739@qq.com

Abstract. Low-cost airlines with emerging business and network operating model, have undergone decades of development, and become an integral part of the global aviation market, the network construction process and evolution mechanism present a particularity, so researching the model of route entry has a certain theoretical value and practical significance. The paper chooses Spring Airlines to carry out case analysis. Although China lags behind other liberalized aviation markets in low cost carrier development, its largest low-cost carriers, Spring Airlines, has achieved rapid growth in traffic volume and revenue, as well as consistent profitability, since its inauguration in 2005. This paper establishes the probit model of airline route entry mode, and uses the airport passenger throughput, population, GDP, HHI index and other indicators to describe the considerations of selecting routes. Using the actual operating data of Spring Airlines obtain the factors of the Spring Airlines selected new routes, then I descript the impact of various factors deeply, and ultimately get the Spring Airlines' entry patterns.

1.Introduction

With the opening of the sky in Europe and the United States, the establishment of Southwest Airlines in 1971 marked the birth of low-cost air operations model [1]. After the success of Southwest Airlines, more and more airlines use the emerging airline business model, low-cost aviation in the global aviation market accounted for a considerable proportion. A large number of studies have shown that the emergence of low-cost aviation business model has brought a series of significant impact, such as the reduction of full-service airlines and industry fares, to promote the development of secondary airports and regional multi-airport production, and the change of people's travel behavior.

Since its inception in 2005, Spring Airlines as China's first private low-cost airlines, in the face of many large state-owned airlines under competitive pressure, has maintained a strong fleet and traffic growth [2]. Taking into account the many restrictions on China's aviation industry regulation and the Spring Airlines and the birth of some low-cost airlines to develop the shackles of the situation, the success of Spring Airlines is undoubtedly a good example.

Taking Spring Airlines as a case study, the influencing factors of low-cost airline route decision-making are theoretically discussed on the basis of actual operational data, which can give a certain theoretical basis for the choice of low-cost airlines in China.

2.The establishment of the airlines' entry model

In order to determine the determinants of airline access, we can build a discrete selection model based on the actual observed airline's decision-making behavior. Here, we choose to use the probit model,

probit model is a generalized linear model, subject to normal distribution. We define Y^* as a measure of the profitability of airlines after entering the route. Then Y^* is related to the observed various market characteristics X .

$$Y^* = X\beta + \mu \tag{1}$$

In the formula (1), u is an unobservable error, we assume that it has a normal distribution with a mean of 0 and a variance of 1.

The basic premise of the empirical model is that the airline only chooses to enter the expected profit Y_t^* is greater than the route to enter the threshold W_t .

$$y_t = \begin{cases} 1, Y_t^* - W_t > 0 \\ 0, Y_t^* - W_t < 0 \end{cases} \tag{2}$$

In equation (2), when y_t is equal to 1, it indicates that the airline has chosen to enter the route; if y_t is equal to 0, it will not enter the route.

On this basis, I got the airline's entry model [3-5], as shown in formula (3)

$$\begin{aligned} \ln Y_i^* = {} & u_0 + u_1 \ln AirportVol_i + u_2 \ln ASK_i + u_3 \ln Pop_i + u_4 \ln GDP_i + u_5 Maxcity_i + u_6 Mincity_i \\ & + u_7 Hub_i + u_8 \ln RouteHHI_i + u_9 MaxairportHHI_i + u_{10} MinairportHHI_i + u_{11} \ln Dist_i + \varphi_i \end{aligned} \tag{3}$$

Where

Y_i^* : The expected profitability of the airline on route i.

$AirportVol_i$: the geometric mean of OD airports' total traffic volumes (scheduled seats) on route i.

ASK_i : the available seat kilometers on route i.

Pop_i : the geometric mean of the population of the city where the OD airports is located on route i.

GDP_i : the geometric mean of the per capita GDP of the city where the OD airports is located on route i.

$Maxcity_i$: The maximum of the number of cities served by Spring Airlines from the endpoint cities on route i.

$Mincity_i$: The minimum of the number of cities served by Spring Airlines from the endpoint cities on route i.

Hub_i : The variable is taken as 1if the only commercial airport at either of the endpoint cities is the hub of Spring Airlines [6].

$RouteHHI_i$: the HHI index on route i.

$MaxairportHHI_i$: The maximum value of the HHI index at both ends of the route.

$MinairportHHI_i$: The minimum value of the HHI index at both ends of the route.

$Dist_i$: flight distance from route i.

φ_i : the factors that can't be observed on route i.

This paper will be divided into five categories: market characteristics, urban characteristics, market competition indicators, network structure and distance factors.

(1) the use of $AirportVol_i$ and ASK_i is to describe the actual market demand, the reason why using $AirportVol_i$ is that the annual passenger throughput of the airport has a large number of

traffic demand, representing a huge market size, and ASK_i said the current route of passenger demand.

(2) using Pop_i , GDP_i is to describe the potential market demand.

(3) $Maxcity_i$, $Mincity_i$ and Hub variables examine whether airlines have more emphasis on the airports that have already provided transport services when they choose to enter new routes. Taking into account the airline's existing route network, it is clear that the new service at the airport has already entered the scale economy. In addition, for its own base airport, the brand has a better understanding, opened up the new routes will have more regular support.

(4) using $RouteHHI_i$, $MaxairportHHI_i$, $MinairportHHI_i$ and other indices are to describe the degree of market competition [9]. In general, HHI index is high, indicating that manufacturers will tend to monopolize the market, the pricing power is mastered by a small number of companies. For the air transport market, these industries are highly concentrated routes or airports often possess higher proportion of passengers, they have a higher brand loyalty to the airline. For low-cost airlines, it is necessary to compete with its most attractive low-cost characteristics, there is a certain degree of difficulty.

(5) $Dist_i$ is used to control the cost factors that airlines consider when choosing to enter a new route, but also characterize the characteristics of the airline's choice of route distance.

3.Case study-spring airlines

3.1Data introduction

The number of available seat and segment distance data for the Chinese airline route market is derived from the OAG database. In addition, the urban population, per capita GDP data from the Chinese knowledge network to provide China's economic and social development statistics database, high-speed rail access data from the China Railway Customer Service Center website to provide passenger train timetable.

In this paper, I used the Spring Airlines' operating data in 2011 to 2016. In order to rule out the occasional charter flights, only when the available seats on the route is more than 5000, we select this route. Because the study of Spring Airlines in the five years of decision-making, so the value of explanatory variables, including airport throughput, population, per capita GDP are based on 2011 data. The selected routes include the number of seats available in 2011, the top 600 routes in the domestic market, and the smaller routes of the Spring Airlines choose to service. Due to the HHI index, we will remove the routes that Spring Airlines had no service in 2011, and finally 613 observations were used to estimate the probability model.

The descriptive statistics of the data used are shown in Table 1.

Table 1. Observational statistics of observations.

Variable	Obs	Mean.	Std	Max	Min
Airportvol（0,000）	613	1358.15	875.39	52.03	5940
Ask（0,000）	613	57963.81	84702.07	362.34	806000
Pop（0,000）	613	588.24	270.24	41.78	1326.9
Gdp	613	60179.47	17827.67	15742.95	116011
Routehhi	613	5037.92	2506.35	1527.48	10000
Dist	613	1090.29	543.57	169.00	3310
Maxcity	613	5.36	7.50	0.00	28

Mincity	613	0.88	1.14	0.00	11
Maxairporthhi	613	2804.37	1776.93	1100.02	10000
Minairporthhi	613	1740.90	590.01	1085.29	10000
Hub	613	0.20	0.40	0.00	1.00

3.2Probit model and its result

Multiple collinearity tests and heteroscedasticity tests were performed on the model. The results are shown in Table 2. Collinearity test results show that VIF values are less than 10, so that there is no multiple collinearity. The P value of the Heterogeneity test is less than 0.05, so it is considered that there are heteroskedasticity.

Table 2. Multicollinearity test of probit model.

Variable	VIF	1/VIF
Hub	5.04	0.198296
Maxcity	4.62	0.216472
Ask	4.42	0.226252
Airportvol	3.99	0.25065
Routehhi	2.44	0.410246
Maxairporthii	2.26	0.4432
Minairporthii	1.61	0.620186
Dist	1.56	0.639033
Pop	1.47	0.682261
Mincity	1.32	0.757252
gdp	1.27	0.788476
MeanVIF	2.73	0.366300

According to the actual operation data of Spring Airlines, we established the corresponding probit model.

Here the use of robust standard deviation to solve the possible inaccurate standard deviation estimates due to heteroskedasticity, the final results are shown in Table 3.

Table 3. The robust estimation of probit model.

Variable	Coef	Std.Err.	z	P>|z|	[95%Conf.Interva]	
Airportvol	0.21086	0.26530	0.79	0.427	-0.3091	0.73086
Ask	-0.74958	0.18955	-3.95	0	-1.1211	-0.3780
Pop	-0.08726	0.13087	-0.67	0.505	-0.3437	0.16925
Gdp	-0.32601	0.38607	-0.84	0.398	-1.0827	0.43068
Routehhi	-0.6417	0.26358	-2.43	0.015	-1.1583	-0.1251
Dist	1.44142	0.27165	5.31	0	0.9089	1.97387
Maxcity	0.01277	0.0176	0.73	0.468	-0.0219	0.04731
Mincity	-0.13606	0.11382	-1.2	0.232	-0.3592	0.08702
Maxairporthhi	-0.01517	0.30649	-0.05	0.961	-0.6159	0.58556
Minairporthhi	-0.47601	0.48215	-0.99	0.324	-1.4210	0.46901
Hub	0.97206	0.38383	2.53	0.011	0.2198	1.72436

_cons	12.2951	5.97961	2.06	0.04	0.5753	24.0149

According to Table 3. Ask and Routehhi have a strong negative effect at 1% and 5% significance levels, which indicates that Spring Airlines is more willing to enter some low-traffic and low-level routes to some extent. A considerable part of these routes is navigable in the second-tier airport, the results also reflects the Spring Airlines positioning in the leisure travel and price-sensitive business travelers target market. At the same time, it is worth mentioning that some of the second-tier airport's local government provided attractive economic subsidies for Spring Airlines. In order to encourage the operation of Spring Airlines in the local airport, Changde, Huaihua, Mianyang and Jinjiang and other local governments provide airport discounts and cash subsidies and other preferential policies for the Spring Airlines. According to the IPO prospectus of Spring Airlines released in 2014, Spring Airlines t received 522 million yuan from the local government in 2013, accounting for 8% of total revenue. And Spring Airlines compared to other full-service airlines there is a great cost advantage, although the traffic on the route is not high, it is still able to maintain a substantial level of profit.

The Hub variable used to describe the Spring Airlines hub is also positive for the important position of the Shanghai Pudong, Shanghai Hongqiao, Shijiazhuang and Shenyang airports in the Spring Airline's network structure. Spring Airlines tends to add new routes at its own base reflects economies of scale. At the same time, more flights at the base airport also help the company to facilitate the deployment of aircraft, but also greatly improve the aircraft utilization. Liang Kai-yan [6] proposed that passengers were very sensitive to the travel time and flight punctuality of the flight. The airline could reduce the number of abnormal flights and improve the service level by optimizing the flight of the hub airport.

The Dist variable significantly shows the characteristics of the route that Spring Airlines is more likely to enter a longer distance, which seems to be contrary to the characteristics of low-cost aeronautical short-haul flights. It may be related to China's high-speed rail project, which began operations in 2008. Due to space constraints, the operation of high-speed rail in 2008 is not presented in a table.

According to statistics, in the Spring Airlines new 83 routes, the number of direct high-speed rail is 26, only accounting for 31.1% of the total, routes that opened ordinary train are 57, accounting for 69% of the total. The average distance of these new entrances is 1364.4 km, which is 1.24 times the average range of 1102.9 km of total 2293 routes in 2016, which also reflects Y Jiang indicated Spring Airlines prefer to choose a longer route from the phenomenon. It is undeniable that in the face of China's rapid development of high-speed rail projects, the aviation industry is indeed in the short-distance transport by the impact. Spring Airlines also changed the development strategy in a timely manner, to expand services on long-distance routes.

4.Conclusion

According to the previous analysis of the entry patterns of Spring Airline, we have got a few important factors when Spring Airlines opened up new routes to consider. Spring Airlines is not willing to offer services on high-traffic routes between large hubs, and more willing to select routes out of its base airport Shanghai Hongqiao, and Shanghai Pudong, as well as routes that links second-line airport such as Shijiazhuang, Shenyang. At the same time, in order to take into account the other regions of the domestic market, but also opened a large number of flights in Lanzhou and Kunming. In the face of the impact of high-speed rail, Spring Airlines will be the goal of market development on the routes that possess longer distance and bear smaller impact from the high-speed rail. Although the choice of a longer route may bring some problems to its flight deployment and the improvement of aircraft utilization, this measure does avoid the problem of reducing the source because of the high-speed rail. When Spring Airlines provide services at various small airports, it makes full use of its leading cost advantage, the use of second-line airport subsidies and low-cost flights, it is also in the operation of the route, but also to seek common development with the airport and the city where the airport is located.

While our empirical survey provides new insights into important markets, there are some limitations to our research. Due to data constraints, we can not observe the actual traffic volume of Spring Airline, thus using the predetermined capacity (number of seats) as a proxy variable. Further studies should be carried out when better data are available.

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