Comparative analysis of route selection behaviors between full-service and low-cost airlines

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Abstract. In order to study the similarities and differences between the route selection strategies of full-service and low-cost airlines, Spring Airlines and Eastern Airlines are representatives of low-cost and full-service airlines respectively, and based on the actual operation data of Spring Airlines and Eastern Airlines routes in the past seven years, the panel-probit model is used to investigate the impact of route characteristics, airport characteristics, characteristics of competing airlines, and the characteristics of airlines on the route selection behaviors of full-service and low-cost airlines. The results show that the route HHI, time slot control airport, airport size and number of competitors have a significant impact on the route decision of the Eastern Airlines, while the time slot control airport, airport HHI and serviced airports have a significant impact on the route decision of the Spring Airlines. Finally, based on the empirical results, the similarities and differences between the decision of Eastern Airlines and Spring Airlines routes are summarized, which provides a theoretical basis for the decision-making of full-service and low-cost airlines.

1. Introduction
The route is one of the elements of the construction of the route network and is the basic condition for aviation system to provide transportation services. The rapid development of China's economy, the demand for civil aviation transportation network will certainly bring about the establishment of new routes in the aviation network [1]. Therefore, in the market competition environment, how to choose a new route becomes an urgent problem for airlines to solve.

This paper selects the historical operational data of Spring Airlines (9C) and Eastern Airlines (MU) in 2010-2017 to study the decisive factors affecting airline route selection. The reason why Spring Airlines and Eastern Airlines will be selected as research objects is that Spring Airlines and Eastern Airlines are the more successful airlines among low-cost airlines and full-service airlines, respectively, studying their route selection model has great significance for other airlines. On the other hand, the headquarters of these two airlines are all in Shanghai, choosing them can avoid the economic advantages brought by Shanghai's strong economic strength. The impact of the experimental results can be more objective and accurate to study the differences in the route selection strategies of the two airlines.

2. Research methods
For a particular route, airlines only choose and do not choose two decision-making behaviors, which have the typical characteristics of a binary selection model. Boguslaski et al. [2] studied the market
entry mode of Southwest Airlines based on the probit model, and more accurately analyzed the types of routes that Southwest Airlines preferred.

The airline route decision behavior is defined as event $Y$. It is assumed that the probability of occurrence of event $Y$ is $P(Y)$, $y_i$ is the decision variable of whether airline chooses route $i$, and the factors that influence route decision include route characteristics, airport characteristics, characteristics of competitive airlines and the characteristics of the airline itself, etc., expressed as $x_0, x_1, x_2, ..., x_i$, then the value of $y_i$ is related to the influence factors $x_i$ of various route decisions. The airline chooses the route that enters the expected profit $y^*$ greater than the profit threshold $W_i$ of the airline operation, that is

$$y_i = \begin{cases} 1, & Y_i^* - W_i > 0 \\ 0, & Y_i^* - W_i < 0 \end{cases} \quad (1)$$

In formula (1), when $y_i$ is equal to 1, it indicates that Spring/Eastern Airlines chooses to enter route $i$; if $y_i$ is equal to 0, it indicates that Spring/Eastern Airlines does not choose to enter route $i$.

The probability of the route decision variable $y_i$ (the dependent variable takes 1 or 0) is

$$P(Y) = P(y_i = 1|X_i, \beta) = f(X_i, \beta) = f(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k) \quad (2)$$

In equation (2), $X_i$ is the vector formed by all the explanatory variables on the sample route $i$, that is, the influence factors of the route decision, $\beta$ is the vector formed by the coefficients, and the probability of $y_i = 1$ is a function of $x_i$, where $f(x_i)$ obeys the standard normal distribution.

3. Empirical analysis

3.1 Data sources and choices

Based on the actual operational data of all airlines provided by the OAG database in 2011-2017, the routes that have been operated (served) for seven years are selected as potential entry route samples. In order to ensure the continuity of data, we eliminate the discontinuous operation and the lack of data, and let the last remaining 579 routes as a sample of potential entry routes. In order to delete a charter flight with a lower frequency, a route with a total annual frequency of 20 or more is defined as the service being served [3]. If Spring/Eastern Airlines does not serve the route during the previous period, and serve the route during the current period. It is said that Spring/Eastern Airlines will choose this route at this stage. Otherwise, Spring/Eastern Airlines will not choose this route at this stage.

3.2 Probit empirical model, variable description and data processing

Combined with the selected route decision factors and correlation analysis results, the expression of the Spring/Eastern Airlines route selection strategy is obtained (3) [4-5].

$$\text{Entry}_C + \text{Entry}_M + \text{MU}^* = u_0 + u_1 \text{Dist}_i + u_2 \text{Passenger}_i + u_3 \text{Slot}_i + u_4 \text{MaxAirFli}_i + u_5 \text{MinAirFli}_i$$

$$+ u_6 \text{Tourist}_i + u_7 \text{SerBothEnds}_i + u_8 \text{MaxOwnShfli}_i + u_9 \text{MinOwnShfli}_i + u_{10} \text{NumRivBothEnds}_i$$

$$+ u_{11} \text{RouteHHI}_i + u_{12} \text{MaxAirHHI}_i + u_{13} \text{MinAirHHI}_i + \phi_i \quad (3)$$

In equation (3), the variables are defined as shown in Table 1.

| Variable | Variable meaning |
|----------|------------------|
| Entry $\_9C$ / $MU^*$ | At time $t$, if the Eastern/Spring Airlines chooses to service route $i$, the variable takes a value of 1, otherwise, the variable takes a value of 0. |
Influencing factors that cannot be observed on route \(i\) are shown in Table 2.

The decision-making behavior of the Eastern/Spring Airlines specific route in a specific year is 3,474 0.176605 0.064208 0.095698 1 0.233966 0.113713 0.095698 1

The probit model analysis of the panel data was performed using the software Stata 11, and the estimation results of the Eastern Airlines are shown in Table 3.

Table 2. Descriptive statistics of MU and 9C’s explanatory variables

| Variable                      | Obs | Mean(MU)  | Std. Dev. | Min | Max | Mean(9C)  | Std. Dev. | Min | Max |
|-------------------------------|-----|-----------|-----------|-----|-----|-----------|-----------|-----|-----|
| Entry _9C / MU \(_i\)         | 3,474 | 0.02677  | 0.161435 | 0   | 1   | 0.005181  | 0.071805 | 0   | 1   |
| Dist, \(_i\)                  | 3,474 | 1200.088 | 630.2895 | 151 | 3924| 1200.088 | 630.2895 | 151 | 3924|
| Passenger\(_i\)               | 3,474 | 0.607002 | 0.306851 | 0.126533 | 1 | 0.607002 | 0.306851 | 0.126533 | 1 |
| Slot, \(_i\)                  | 3,474 | 219118.3 | 314845.2 | 1034 | 3194586 | 219118.3 | 314845.2 | 1034 | 3194586 |
| MaxAirFli\(_i\)               | 3,474 | 0.310881 | 0.462921 | 0   | 1   | 0.310881 | 0.462921 | 0   | 1   |
| MinAirFli\(_i\)               | 3,474 | 0.310335 | 0.192931 | 0.104167 | 1 | 0.195613 | 0.099663 | 0.095698 | 1 |
| Tourist, \(_i\)               | 3,474 | 0.110535 | 0.313601 | 0   | 1   | 0.80167  | 0.3988   | 0   | 1   |
| SerBothEnds\(_i\)            | 3,474 | 0.085768 | 0.127653 | 0   | 1   | 0.226937 | 0.525878 | 0   | 1   |
| MaxOwnShfli\(_i\)             | 3,474 | 0.1599016 | 17556.02 | 31 | 150409 | 2766.79 | 9576.273 | 0   | 150409 |
| MinOwnShfli\(_i\)             | 3,474 | 0.110535 | 0.313601 | 0   | 1   | 0.80167  | 0.3988   | 0   | 1   |
| NumRivBothEnds\(_i\)         | 3,474 | 0.085768 | 0.127653 | 0   | 1   | 0.226937 | 0.525878 | 0   | 1   |
| RoutepHHI\(_i\)              | 3,474 | 0.1599016 | 17556.02 | 31 | 150409 | 2766.79 | 9576.273 | 0   | 150409 |
| MinAirHHI\(_i\)              | 3,474 | 0.110535 | 0.313601 | 0   | 1   | 0.80167  | 0.3988   | 0   | 1   |

3.3 Analysis of results

The probit model analysis of the panel data was performed using the software Stata 11, and the estimation results of the Eastern Airlines are shown in Table 3.
According to the estimation coefficient and significance test results of the panel probit model, the influence degree of each influencing factor on the decision of the Eastern/Spring Airlines route is compared and analyzed.

In terms of route characteristics, for the route distance variable \( Dist \), the coefficient of Eastern Airlines is negative, the value is \(-5.4E-05\), the coefficient of Spring Airlines is positive, the value is \(0.000155\), the coefficient of the two is small and neither is significant. This indicates to a certain extent that the route distance has less influence on the route decision of Spring Airlines and Eastern Airlines.

For the route density variable \( \text{Passenger}_{i,j} \), the coefficient of the Eastern Airlines and Spring Airlines is small and not significant, indicating that the Eastern/Spring Airlines did not consider the route density as an important consideration when selecting the route. The higher the number does not mean the more passengers can be obtained.

In terms of airport characteristics, for the time slot control airport variable \( \text{Slot} \), the coefficient of Eastern Airlines is \(-0.25164\), which is significant at 90%. The coefficient of Spring Airlines is \(1.149121\), which is significant at 95%. This indicates that Eastern Airlines does not tend to enter the time slot control airport, because the time slot control airport’s time has a high purchase cost, the competition situation is severe at the time slot control airport. Spring Airlines tends to enter the time slot control airport, because the time slot control airport tickets have higher fares and the passengers are generally higher, Spring Airlines enters it to take advantage of low fares and attract more travelers.

The \( \text{MaxAirFli}_{i,j} \) variable and \( \text{MinAirFli}_{i,j} \) variable used to characterize the airport scale, the coefficients of Eastern Airlines are \(-1.9E-06\), \(5.46E-06\), and the coefficients of Spring Airlines are \(2.93E-06\), \(2.07E-05\), respectively, and the variable \( \text{MaxAirFli}_{i,j} \) of Eastern Airlines is significant at 90%, indicating that Eastern Airlines is not inclined to enter larger airports, because there are more competitors in larger airports, and the high fares of full-service airlines reduce their competitive advantage. While Spring Airlines tends to enter larger airports, Spring Airlines can take advantage of low fares to get more passenger. For the tourist city, the \( \text{Tourist} \) variable, the coefficient of Eastern Airlines is \(0.065655\), the coefficient of Spring Airlines is \(0.312062\), and the coefficient of Spring Airlines is 5 times that of Eastern Airlines, indicating that Spring Airlines is more inclined to enter the tourist city, which also verifies that the target passengers of Spring Airlines are mostly price-sensitive passengers.

In terms of the characteristics of the airline itself, for the \( \text{SerBothEnds}_{i,j} \) variable, the coefficient of Eastern Airlines is \(0.020753\), the coefficient of Spring Airlines is \(1.192231\), and it is significant at the 90% confidence level, indicating that Spring Airlines is more inclined to open up at the airport where it has served. On the route, the airline expands the route based on the existing service airport, and can better utilize the existing resources of the service airport, thereby reducing operating costs and
improving economies of scale. The $MaxOwnShfli_{i,j}$ and $MinOwnShfli_{i,j}$ variables used to characterize the market share of Eastern/Spring Airlines in the endpoint airport, the coefficients of Eastern Airlines are 0.469064 and -0.80488, respectively, and the coefficients of Spring Airlines are 0.254352 and 0.025984 respectively, indicating that Eastern Airlines and Spring Airlines both tend to enter the airport with a large market share to get more frequent visitors.

In terms of competitor characteristics, the $NumRivBoth Ends_{i,j}$ variable used to characterize the number of competitors entering the market, the coefficient of Eastern Airlines is -0.04264, and is significant at 95%, the coefficient of Spring Airlines is -0.0601, which indicates that Eastern Airlines is less inclined to enter the market with more competitors, because the fares of full-service aviation are generally higher and it is not easy to gain a competitive advantage. Therefore, Eastern Airlines avoids entering a more competitive market. For route HHI, the $RouteHHI_{i,j}$ variable, the coefficient of Eastern Airlines is -0.36385, the coefficient of Spring Airlines is -1.44331, and Eastern Airlines is significant at 90%, indicating that neither of them tends to enter a market with higher concentration of competition, because the greater the HHI value of the market, the higher the monopoly status of a single airline which have the more frequent visitors, the less market power that Spring/ Eastern Airlines can obtain after entering the market. The $MaxAirHHI_{i,j}$ and $MinAirHHI_{i,j}$ variables used to characterize the market concentration of the airport, the coefficients of Eastern Airlines are -0.64346, 0.228521, and the coefficients of Spring Airlines are - 5.56623, 0.214732, respectively, and the $MaxAirHHI_{i,j}$ variable of Spring Airlines are significant at 90%. This indicates that Eastern Airlines and Spring Airlines are inclined to enter the market with lower market concentration to reduce competition with local airlines and obtain more passengers.

Based on the analysis of the factors affecting the route decision of Eastern/Spring Airlines, the same points of the full service and low cost airlines route decision are: 1) Both are not inclined to enter a market with high concentration of competition. 2) Both are not inclined to enter a market with more competitors. 3) Both do not consider route distance and route density as the main considerations. 4) Both tend to open routes on airports that have already served, and Spring Airlines has a higher tendency to obtain economies of scale and reduce costs. 5) Spring and Eastern Airlines are inclined to open routes at airports with a large market share to obtain more frequent flyers. The difference between full service and low cost airlines route decision is mainly reflected in whether it is inclined to enter the time slot control airport and the larger airport. There are many airlines serving in the time slot control airport and the larger airport. With high service quality and low aircraft utilization, Full service airline fares have been at a high level and it is difficult to gain a competitive advantage. Therefore, Eastern Airlines does not tend to enter time slots to control airports and larger airports. Spring Airlines, on the other hand, has a lower fare because of its cost control, and it is easier to obtain more passengers and has a competitive advantage, Spring Airlines is more inclined to enter the time slot control airport and larger airports.

4. Conclusion
Based on the existing network of airlines and market competition, this paper empirically analyzes the factors affecting the route decision of Eastern Airlines and Spring Airlines, and summarizes the similarities and differences between the two airlines in route decision-making. The purpose is to provide a theoretical basis for the operation of full-service and low-cost airlines while summarizing the route selection strategy of Eastern Airlines and Spring Airlines, and promote the development of low-cost aviation market.

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