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A Multivariate Probit Model for Analyzing Travelers' Choice of Airline Carrier

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Περίληψη

Στη μελέτη αυτή διερευνώνται οι παράγοντες που επηρεάζουν τις αποφάσεις των επιβατών σχετικά με την επιλογή αεροπορικής εταιρείας. Αναπτύσσονται πολυμεταβλητά μοντέλα διακριτής επιλογής Probit προκειμένου να αναλυθούν δεδομένα από ένα δείγμα 853 ερωτηθέντων. Η μεθοδολογία αυτή επιτρέπει τη διερεύνηση τόσο της επίδρασης κάθε παράγοντα όσο και της συνέργειας μεταξύ των παραγόντων στη διαμόρφωση της επιλογής αερομεταφορέα. Η τιμή του εισιτηρίου, η ασφάλεια και αξιοπιστία του αερομεταφορέα, καθώς και το φιλικό και εξυπηρετικό προσωπικό κατά τη διάρκεια της πτήσης, είναι οι κυριότεροι παράγοντες που καθορίζουν την επιλογή αεροπορικής εταιρείας. Η εν-πτήση ψυχαγωγία και το πρόγραμμα κινήτρων για τους τακτικούς επιβάτες βρίσκεται να είναι λιγότερο σημαντικοί παράγοντες σύμφωνα με την γνώμη των επιβατών. Τα αποτελέσματα δείχνουν επίσης ότι η σημαντικότητα των παραγόντων εξαρτάται από τα δημογραφικά και τα χαρακτηριστικά μετακίνησης του κάθε επιβάτη.

Λέξεις κλειδιά: *πολυμεταβλητά μοντέλα διακριτής επιλογής Probit; επιλογή αεροπορικής εταιρείας; τιμή εισιτηρίου; ασφάλεια και αξιοπιστία; χαρακτηριστικά μετακίνησης.*

Abstract

We investigate the factors that affect passenger decisions regarding airline choice. Three Multivariate Probit (MP) models are developed to analyze data for a sample of 853 respondents. This methodology allows for modeling the simultaneous, yet separate, consideration of airline choice determinants. Fare, safety and reliability, and friendly-and-helpful staff during flight are the most important determinants of airline choice. In-flight entertainment and frequent flyer program are considered to be less important. Results clearly depict differences in the significance of these factors among passengers with different socio-demographic and trip characteristics.

Keywords: *multivariate probit model; airline choice; fare, safety and reliability, trip characteristics.*

1. Introduction

The increase in the number of operators in the airline industry has resulted in increased competition among airlines as travelers are called to make a choice among homogenous products (Ukpere et al., 2012). Many airline companies try to explore and implement focused/customized marketing strategies that will lure travelers with different socio-demographic and trip characteristics (Gilbert and Wong, 2003). Identifying passenger expectations is essential in order to provide the desired airline services. Many studies have investigated the factors that influence decision making related to airline choice. However, the importance of each factor differs among travelers and depends mainly on their socio-demographic attributes and trip characteristics (Gilbert and Wong, 2003).

In this paper we investigate the factors that influence airline choice based on the analysis of a sample of 853 respondents. We identify the service dimensions (factors) that are perceived as important to passengers regarding airline choice. We aim: first, to explore traveler perceptions regarding the importance/significance of factors that determine their choice of airline. Second, to analyze the socioeconomic and trip characteristics that determine perceived importance of these factors. Third, to give insight into understanding passenger perceptions regarding the factors that are important when making traveling arrangements that lead to making policy decisions. The relevant research questions pertaining to this study are:

1. *Why does a traveler consider a factor (service) to be important or unimportant regarding airline choice?*
2. *Do socioeconomic and trip characteristics play a role regarding this consideration?*

2. Background

Many researchers have examined the factors that influence the choice of airline carrier; perceptions of air travel service quality and fare have been identified as the most important factors influencing the choice of airline (Ukpere et al., 2012). Ostrowski et al. (1993) report that service quality is a more important factor that affects passenger satisfaction than fare, while Hess et al. (2007) found that fare is the variable with the greatest explanatory power. Pre-bookable services and value added services such as frequent flyer programs, have been also identified as ways for increasing customer satisfaction in a highly competitive market (Dennett et al. 2000). An airline image can also be a significant factor regarding airline choice (Connor and Davinson, 1997). Several researchers found that sociodemographic characteristics such as income, age, gender tend to exert a significant impact on the significance of service quality dimensions (Clemes et al., 2008). Park (2007) investigated passenger perceptions of eleven factors that may influence airline choice and found that significant differences exist across different seat classes, usage frequencies and airlines.

There is also a wealth of literature analyzing the determinants of passengers intensions regarding full services and low cost carriers (Mason and Alamdari, 2007; Ong and Tan, 2010; Chiou and Chen, 2010; Edwards, 2011). In their study, Castillo-Manzano and Marchena-Gomez (2011) found that trip attributes such as destination, purpose, and trip duration conditioned traveler choice. Moreover, booking methods, concerns for fares, and concerns for flight schedule, are significant in determining airline choice (Ong and Tan, 2010). Mason (2001) and later studies by Evangelho et al. (2005) and Fourie and Lubbe (2006) investigated business travelers' choice of airline (low cost carriers or full service airlines), and found that business travelers differ in the way they are influenced by service factors compared to leisure travelers.

3. Data

To analyze air traveler perceptions, we designed a detailed questionnaire. In the first part, respondents provided information on their trip characteristics such as purpose of the trip, final destination, booking method, cost of ticket, and mode of transport used to reach the airport. In the second part, respondents were asked whether factors such as fare, flight schedule, frequent flyer program, in-flight entertainment, are important regarding airline choice. Third,

respondents were asked whether they would switch to another airline for the benefit of a reduced fare. Finally, data on traveler socio-demographic characteristics were obtained.

The questionnaire was completed via personal interviews at the Athens International airport Eleftherios Venizelos. The field survey was conducted on December 2012, on working days and during different hours of the day (08:00-18:00). Respondents were chosen at random in order to capture different population and trip characteristics. A representative sample of 853 passengers older than 18 years was collected. Table 1 presents summary statistics for selected variables for each section of the questionnaire.

Table 1 *Summary statistics of selected variables*

Variables	Percentages
1st section of the questionnaire (characteristics of the trip)	
Airline (Aegean/ Easyjet/Olympic/Cyprus/Other)	(24/11/14/9/42)
Final destination (Greece/East Europe/West Europe/Asia/Africa/America/Australia)	(26.38/16.88/41.03/7.62/2.23/4.57/1.29)
Mode of transport used to reach El. Benizelos (Car/Taxi/Metro/ Bus/Airplane)	(30.13/13.25/19.11/13.83/23.68)
Distance travelled to El Benizelos (0-10km/ 11-30km/ 31-50km/>50km)	(2.46/28.02/34.23/35.29)
Journey (one way/ round trip)	(35.52/64.48)
Connection to another airline	(33.88/66.12)
Booking method (airline website/ travel agent/ telephoned airline call center/ purchased today/ other)	(63.89/30.83/1.76/2.34/1.17)
How long ago did you book (0-5days/5-15 days/ 16-30days/ 31-60days/ >60days)	(20.87/25.67/26.85/15.71/10.90)
Who paid (Self/ Parent/ Gift/ Company / Other)	(64.71/13.95/2.23/17.23/1.88)
Price of the ticket (<150€/ 150-300€/ 300-450€/ 450-600€/ >600€)	(29.43/42.79/13.83/4.10/9.85)
Purpose of the journey (business/ Holidays/ Studying/Other)	(32.12/42.20/2.81/22.86)
2nd section of the questionnaire	
Factors that influence the choice of the airline carrier	
Fare (1 if it is an important factor; 0 otherwise)	88.16
Safety and reliability (1 if it is an important factor; 0 otherwise)	77.60
The whole airline's image (1 if it is an important factor; 0 otherwise)	72.22
Friendly and helpful staff in flight (1 if it is an important factor; 0 otherwise)	63.42
Friendly and easy to use website (1 if it is an important factor; 0 otherwise)	59.91
Connections until destination (1 if it is an important factor; 0 otherwise)	52.75
In-flight entertainment (1 if it is an important factor; 0 otherwise)	29.68
Large number of the cities served (1 if it is an important factor; 0 otherwise)	24.74
Frequent flyer program (1 if it is an important factor; 0 otherwise)	21.64
Friend's/ Agent's recommendation (1 if it is an important factor; 0 otherwise)	14.54
3rd section of the questionnaire (Socioeconomic Characteristics)	
Age (18-24/ 25-35/ 36-44/ 45-54/ 55-64/>65)	(17.35/34.94.16.18/14.54/12.90/4.10)
Gender (male/ female)	(53.81/46.19)
Nationality(Greek/ in EU/ out of EU)	(72.92/20.52/6.57)
Level of education (Primary/ Secondary/ Tertiary)	(3.52/25.67/70.81)
Monthly income (<800/ 800-1500/ 1500-2500/ >2500)	(25.44/35.29/21.92/17.35)
Sector of employment (self-employed, civil service, private employed, retiree, unemployed)	(23.33/11.37/40.45/7.85/17.00)
Number of observations	853

The summary statistics indicate that fare, safety and reliability as well as an airline's image are found to be the most important factors that influence the airline choice, while in-flight entertainment and frequent flyer program are considered to be less important. The results are very much in line with the previous research of Alamdari (1999) who found that although in-flight entertainment is a factor influencing airline choice, it is not regarded as one of the most important; fare and reliability were found to be more important. The majority of respondents consider flight schedule (convenience and sufficient frequencies) and easy to use website to be crucial factors regarding choice.

4. Methodology

4.1. Multivariate Probit Model

The multivariate probit model is used for analyzing the factors that significantly influence airline choice. The multivariate probit model is one form of a correlated binary response regression model that simultaneously estimates the influence of independent variables on - more than one - dependent variables, and allows for the error terms to be freely correlated. The dependent variable represents positive (important or 1) or negative (unimportant or 0) responses to the question regarding the importance of each factor on airline choice. Trip characteristics (booking method, final destination, purpose of the trip, cost of the ticket), as well as socio-demographic characteristics (income, age, nationality, education level, gender), were used as independent variables.

The multivariate probit model is based on the multivariate normal distribution and is recommended in cases of independence among the irrelevant alternatives (Greene, 2003). We note that, in the past, multivariate probit models have been used in transportation research in a number of cases (Choo and Mokhtarian, 2008; Viswanathan et al., 2000; Goulias et al., 1998; Golob et al., 2002). The general specification for a multivariate probit model of dependent variables (or alternatives) can be expressed as (Greene, 2003)

$$Y_i^* = \boldsymbol{\beta_i X_i} + \boldsymbol{\varepsilon_i}, \quad \text{i=1,…, n} \tag{1}$$

where

Y_i^* defines an unobserved variable representing the latent utility (or propensity) for considering alternative *i*,

X_i is a vector of observed characteristics determining choice alternative *i*

β_i represents a vector of unknown coefficients to be estimated, and

ε_i represents a vector of error terms that are normally distributed with zero mean and constant variance.

The variance-covariance matrix of the error term is given as follows:

$$\Sigma=\begin{bmatrix} 1 & \cdots & \rho 1n \\ \vdots & \ddots & \vdots \\ \rho n1 & \cdots & \rho nn \end{bmatrix} \quad (2)$$

where ρ is a measure of the correlation among the latent utilities.

Multivariate probit models are estimated using simulation methods—most frequently Monte Carlo integration—rather than conventional numerical approaches.

5. Results

Three multivariate probit models were developed to investigate the factors that affect passenger decision regarding airline choice. The eleven factors that were examined were grouped into three categories. The first category (model 1) includes friendly and helpful staff during flight, in-flight entertainment, airline image, and friend's recommendation; the second category (model 2) includes safety and reliability, number of connections until final destination, flight schedule, and large number of cities served; finally, the third category (model 3) includes ticket price and frequent flyer program. Our analysis captures differences in service expectations among passengers for different market segments. Estimation results for the three multivariate models are presented in Tables 2, 3 and 4.

According to the first model, people who use an airline' s website in making reservations, usually do not consider recommendations of a friend/agent in choosing an airline. Crew behavior and on board services have, in general, a significant impact on airline choice (Ukpere et al. 2012). From the second equation of the first model it appears that Greek passengers and people who travel to Asia do not consider friendly and helpful staff during flight to be an important factor, while male travelers are more likely to consider this as a significant choice factor. As ticket cost increases, travelers are more likely to consider in-flight entertainment significant in choosing a particular airline. This probably suggests that people who prefer to travel by airlines that offer higher quality of in-flight entertainment are willing to pay a higher fare. Moreover, travelling to Europe decreases the probability of considering in-flight entertainment to be an important factor when making travel arrangements, probably because the duration of the flight is shorter for these trips.

According to the first Equation of the second model (Table 3), people who travel for business, passengers over 35, as well as people who have a connection to another airline, are more likely to consider flight schedule to be an important factor in choosing an airline. Men, respondents in the 18-35 age group, respondents who travel with low cost airlines, and respondents who use a domestic flight have a lower likelihood of considering safety and reliability as an important factor. Results of the third equation of the second model indicate that people who travel for business have an increased probability of considering the number of connections until destination (non-stop services to various destinations) as an important factor. The statistical analysis also suggests that men have a higher likelihood of considering "large number of cities served" as an important factor affecting airline choice, while respondents over 35 have a lower likelihood of considering this as an important factor.

Table 2: *Multivariate Probit Model 1*

Variables	Coefficient	t-statistic
Y7:Friend' s/Agent's recommendation		
Constant	-0.735	-6.177
Website (1 if the ticket was booked via the airline' s website; 0 otherwise)	-0.163	-1.528
E-Europe (1 if final destination is East Europe; 0 otherwise)	-0.359	-2.319
Greek (1 if nationality is Greek, 0 otherwise)	-0.239	-2.052
Y9:Friendly and helpful staff in flight		
Constant	0.479	4.867
Greek (1 if nationality is Greek, 0 otherwise)	-0.246	-2.368
Men (1 if men, 0 otherwise)	0.154	1.922
Asia (1 if final destination is Asia; 0 otherwise)	-0.483	-3.273
Y10:In-flight entertainment		
Constant	-0.609	-3.008
Ticket cost	0.083	2.358
Greek (1 if nationality is Greek, 0 otherwise)	-0.199	-1.873
W-Europe (1 if final destination is West Europe; 0 otherwise)	-0.215	-2.265
E-Europe (1 if final destination is East Europe; 0 otherwise)	-0.333	-2.423
Y11:Whole airline's image		
Constant	0.164	1.784
Low-cost (1 if the airline is low-cost, 0 otherwise)	-0.189	-1.455
Car-Taxi (1 if the mode used to reach the airport is car or taxi; 0 otherwise)	0.116	1.238
America (1 if final destination is America; 0 otherwise)	-0.391	-2.030
Greek (1 if nationality is Greek, 0 otherwise)	0.612	5.864
Correlation among dependent variables	**Coefficient**	**t-statistic**
Rho (Y7-Y9)	0.413	6.505
Rho (Y7-Y10)	0.437	7.445
Rho (Y9-Y10)	0.587	11.868
Rho (Y7-Y11)	0.229	3.024
Rho (Y9-Y11)	0.549	11.585
Rho (Y10-Y11)	0.375	6.085
Log-likelihood	-1755.404	
Number of observations	853	

Table 3: *Multivariate Probit Model 2*

Variables	Coefficient	t-statistic
Y2: Flight schedule		
Constant	0.389	3.751
Business (1 if the purpose of the trip is business, 0 otherwise)	0.237	2.520
Connection (1 if there is connection to another airline; 0 otherwise)	0.267	2.391
America (1 if final destination is America; 0 otherwise)	-0.704	-3.352
Age >35 (1 if respondents are over 35 years old ; 0 otherwise)	0.220	2.283
Australia (1 if final destination is Australia; 0 otherwise)	-0.869	-1.729
Greek (1 if nationality is Greek, 0 otherwise)	-0.439	-4.245
Y4:Safety and Reliability		
Constant	1.079	9.273
Car-Taxi (1 if the mode used to reach the airport is car or taxi; 0 otherwise)	0.166	1.671
Low-cost (1 if the airline is low-cost, 0 otherwise)	-0.479	-3.145
Today (1 if the ticket was purchased the day of the flight; 0 otherwise)	-0.535	-1.796
Greece (1 if final destination is Greece; 0 otherwise)	-0.192	-1.661
America (1 if final destination is America; 0 otherwise)	-0.390	-1.682
Age 18-35 (1 if respondents are between 18-35; 0 otherwise)	-0.184	-1.833
Men (1 if men, 0 otherwise)	-0.250	-2.447
Y5: Connections until destination		
Constant	-0.747	-0.745
Business (1 if the purpose of the trip is business, 0 otherwise)	0.206	2.020
Connection (1 if there is connection to another airline; 0 otherwise)	0.500	4.550
Low-cost (1 if the airline is low-cost, 0 otherwise)	0.223	1.663
America (1 if final destination is America; 0 otherwise)	-0.544	-2.595
Self paid (1 if respondents paid themselves their ticket; 0 otherwise)	-0.223	-2.435
Men (1 if men, 0 otherwise)	0.199	2.282
Y6: Large number of cities served		
Constant	-0.780	-9.237
Men (1 if men, 0 otherwise)	0.278	2.874
Age >35 (1 if respondents are over 35 years old ; 0 otherwise)	-0.205	-2.017
Greece (1 if final destination is Greece; 0 otherwise)	0.182	1.725
Connection (1 if there is connection to another airline; 0 otherwise)	-0.217	-1.834
Correlation among dependent variables	**Coefficient**	**t-statistic**
Rho (Y2-Y5)	0.459	9.464
Rho (Y2-Y6)	0.408	7.348
Rho (Y5-Y6)	0.461	8.701
Rho (Y2-Y4)	0.118	1.892
Rho (Y5-Y4)	0.210	3.433
Rho (Y6-Y4)	0.243	3.524
Log-likelihood	-1977.977	
Number of observations	853	

Table 4: *Multivariate Probit Model 3*

Variables	**Coefficient**	**t-statistic**
Y1: Fare		
Constant	1.220	9.416
Business (1 if the purpose of the trip is business, 0 otherwise)	-0.668	-5.239
Low-cost (1 if the airline is low-cost, 0 otherwise)	0.454	1.933
Greek (1 if nationality is Greek, 0 otherwise)	0.541	4.171
Men (1 if men, 0 otherwise)	-0.278	-2.158
Y3:Frequent flyer program		
Constant	-1.660	-10.846
Business (1 if the purpose of the trip is business, 0 otherwise)	0.345	3.231
Car-Taxi (1 if the mode used to reach the airport is car or taxi; 0 otherwise)	0.228	1.892
Connection (1 if there is connection to another airline; 0 otherwise)	0.304	2.196
Income	0.234	4.453
Correlation among dependent variables	**Coefficient**	**t-statistic**
Rho (Y1-Y3)	-0.173	-2.254
Log-likelihood	-694.977	
Number of observations	853	

From the first equation of the third model (Table 4), it appears that men and business travelers are less likely to be influenced by airfare level when choosing an airline. This is in line with the study of Gomez-Ibanez and Fauth (1980) who conclude that non-business market segments are generally more price-sensitive. As expected, people who travel with low-cost airlines have a greater tendency to consider fare level as a significant factor affecting the probability of airline choice. It should also be noted that Greek passengers perceive airfare level to be an important factor. This is probably explained by the economic recession in Greece that has resulted to reduced incomes. Finally, business and higher income travelers have a greater tendency to consider frequent flyer programs as an important factor in airline choice. One possible reason is that these target groups travel with greater frequency and, thus, want to take advantage of frequent-flyer miles.

Correlation coefficients among the equations for each model (factors that are important for choosing a particular airline) are presented at the end of each Table. All correlation coefficients are positive and statistically significant at the 90% level both for model 1 and for model 2. This is an indication that unobserved variables for each model are significantly and positively related; it also confirms the efficiency gained by jointly modeling determinants of airline choice.

Another interesting finding of this analysis is the strong correlation between 'in-flight entertainment' and "helpful and friendly staff" and the correlation between the latter and "airline image". The strong (positive) correlation implies that people who consider friendly and helpful staff as an important factor in choosing a particular airline believe that in-flight entertainment and airline image are also important factors. Moreover, based on the results

reported in Table 3 (model 2), people who consider flight schedule as an important factor for airline choice, also consider the number of connections until their final destination to be important (correlation coefficient of 0.459).

6. Conclusions

We investigated the factors that affect passenger decisions regarding airline choice. Combined interactions between these factors (safety and reliability, in-flight entertainment, frequent flyer program) and socioeconomic and trip characteristics are explored. Three multivariate probit models were developed, since it allows for modeling the simultaneous, yet separate, consideration of airline choice determinants.

Fare, safety and reliability, and friendly and helpful staff during flight are the most important determinants of airline choice. The results clearly depict the significant differences among passengers of different nationalities, passengers who travel for different purposes, as well as among different age groups. People who travel for business purposes are less price sensitive and more likely to consider "flight schedule" and "frequent flyer program" to be important in making an airline choice. Further, business travelers have a higher tendency to prefer airlines that provide direct non-stop flights. Passengers that pay higher fares are more likely to appreciate the provision of in-flight entertainment, particularly for longer flights.

Overall, the study provides considerable help in understanding an individual's perceptions regarding the importance of the factors that determine airline choice. Exploiting the significant differences that exist among passengers with different socio-demographic and trip characteristics, airlines could develop targeted marketing policies to attract travelers from different groups.

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