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Impact of Flight Departure Delay on Airline Choice Behavior*

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ABSTRACT

The Korean aviation industry (KAI) has been expanded significantly, because the Incheon International Airport opened in 2001 and low cost carriers (LCC) entered the KAI market. But following the KAI's growth, flight departure delays (FDDs) have increased six-fold during the past decade. In terms of these situations, this study firstly adds the FDD variable to an airline choice behavior (ACB) model and secondly analyses how FDD impact the ACB. As a result, FDD is relatively less influential on ACB than other attributes. Both the flight service and available schedule are positively related to the choice of full service carriers (FSC). The analysis shows that FSCs' allotment rate (AR) is 85.3%, while LCCs' one is 14.7%.

1. Introduction

Because of the 1978 Airline Deregulation Act and the 2001 open skies policy, the global airline industry has gradually grown. In 1978, the United States (US) negated federal government control over such things as fares, routes, and new airlines' entry into the market. The government introduced the 1978 Airline Deregulation Act to make the commercial airline industry a free market, which led to a great increase in the number of flights, decreased fares, and the growth of passenger numbers. "Open skies" is an international policy concept that calls for the liberalization of the rules and regulations of the international aviation industry, especially commercial aviation, to create a free market environment for the industry.

Triggered by these two policies, the airline industry has experienced growth all over the world. According to the International Air Transport Association (IATA), the industry's revenue doubled over recent years from US$ 369 billion in 2004 to US$ 746 billion in 2014. This revenue growth was triggered by the entry of low-cost carriers (LCCs) into the international aviation market, sharing a quarter of air passengers worldwide.

The Korean aviation industry (KAI) has been developed in numerous ways, because of the 1988 Seoul Olympics and the overseas tourism freedom since 1989. Before and just after the 1997 International Monetary

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Fund (IMF) financial crisis, the KAI shrunk somewhat, but since then, it has grown a great deal, because of the Incheon International Airport (IIA) opening in 2001 and the entry of LCCs into the KAI market. The allotment rate (AR) of LCCs was 46% in 2012 and penetrated up to 50% in 2014.

Following the KAI's considerable growth, flight departure delays (FDDs) have increased six-fold during the past decade. According to a report published by the National Assembly of the Republic of Korea (http://korea.assembly.go.kr/), there were 26,136 delayed flights, with 3,948,000 passengers boarding the flights, producing a time loss of 5,452,297 hours in Korean airports, including IIA, over 16 months. If we consider the minimum wage in Korea, the social cost of FDDs was about 826 million won or US$ 709,621.

Some aviation experts have pointed out some limitations to LCCs, such as a lack of aviation mechanics. The case of People Express, a US LCC, vividly shows the limitations of LCCs, leading to frequent FDDs. People Express had gained a great deal of revenue in its growth stage, but it did not invest. The company expanded its flight schedule and service routes, creating flight clerk fatigue and causing technical problems with the flights. In the end, the company went bankrupt.

In spite of the significance of LCC's FDD, several researches dealing with aviation and airports primarily analyse efficiency in terms of operational performance (Oum and Yu, 2004; Yoshida and Fujimoto, 2004; Lam et al., 2009; Yang, 2010; Choi, 2017; Mallikarjun, 2015; Ha et al., 2013; Pires and Fernandes, 2012; Tsui et al., 2014) and ACB (Hess et al., 2007; Jung and Yoo, 2016; Drabas and Wu, 2013). Recent studies have attempted to analyse specific elements of efficiency and productivity, such as energy (Xu and Cui, 2017; Cui and Li, 2016; Cui et al., 2016) and noise (Voltes-Dorta and Martín, 2016), while both Lozano and Gutiérrez (2011) and Fan et al. (2014) only highlighted the importance of delay times for airlines. There is only rare attention paid to FDD problems among airline and airport disciplines.

To fill this research gap, this paper uses stated preference (SP) to analyse how much FDD affects the airline choice behavior (ACB). This study firstly considers FDD in an ACB model, secondly determines how FDD affects ACB.

The remainder of this paper is organized in four sections. Section 2 reviews previous studies related to the aviation industry, air transport, transportation modelling, and modal choice modelling. Section 3 comprises the research design, including data and methodology. Section 4 is the empirical research, while Section 5 discusses the analysis with brief results.

2. Literature review

As with the decision-making process for consumption goods, air passengers display identical consumption patterns when they purchase airline tickets. To define the ACB, it is first necessary to clarify what consumer behavior is. It is the process by which consumers explore, purchase, use, evaluate, and dispose of products to satisfy their needs and wants. To shed light on the mechanisms of consumer behavior, the Engel-Kollat-Blackwell (EKB) theory states that the mechanism by which a consumer decides upon a product from among several substitute goods heavily depends on the individual's internal or external features. Banfe (1992) explained EKB theory using five stages: 1) recognition of a problem, 2) exploration of information, 3) evaluation of alternatives, 4) purchase, and 5) evaluation after purchase. In line with EKB theory, Etherington and Var (1984), Toh and Hu (1990), Kaynak and Kucukemiroglu (1993), Fourie and Lubbe (2006), Hess et al. (2007), and Drabas and Wu (2013) explored and suggested various attributes of ACB, as summarized in Table 1. Most of the highlighted attributes of ACB have dealt with available schedules (AS), flight service (FS), and airfares. This confirms that many passengers consider these attributes important when they choose an airline.

Table 1
Attributes of airline choice behavior

Authors (Year)	Highlighted attributes of Airline Choice Behavior
Etherington and Var (1984)	Available schedule, airport service, flight service, airfare, attitude of flight crew
Toh and Hu (1990)	Available schedule, reliability (on-time service), airfare, overall service of flight crew, premium service, flight service, recommendation of tourism corporation
Kaynak and Kucukemiroglu (1993)	Counter service, exact aviation information, flight crew service, quick baggage handling, convenient flight connectivity, available schedule, reliability, airfare
Fourie and Lubbe (2006)	Comfortable seat, punctuality, airfare, advance service of choosing seat
Hess et al. (2007)	Access time to airport, airfare, total time of flight
Drabas and Wu (2013)	Type of flight, delayed time, punctuality, airfare, refund service, seat level

It is also necessary to review studies of FDD in the aviation and airport disciplines. Lozano and Gutiérrez (2011) analysed the efficiency of airports with respect to delay times, using a slacks-based measure data envelopment analysis model. They then considered delay times as undesirable output. Britto et al. (2012) analysed how FDD affects both passenger demand and airline fares; they determined that FDD decreases both passenger demand and social welfare. Keumi and Murakami (2012) empirically analysed modal choice behavior when passengers moved to an airport. Zou and Hansen (2014), Hao et al. (2014), and Fan et al. (2014) also studied FDD. Hao et al. (2014) measured the impact of FDDs at a New York airport, and Fan et al. (2014) used a distance function to analyse the operational efficiency of airports with respect to FDD.

There are also several previous studies related to research methodology and the logit model on the aviation and airport side. Park and Ha (2006) measured the AR between the Korea Train eXpress (KTX) and domestic flights through the Seoul–Daegu line using the SP method after the KTX entry into the market. Park and Ha (2006) showed that if the one-way airfare for KTX was about US$ 30, the AR was 86%; then the AR of domestic flights was 14%. Lee and Song (2014) analysed the AR between the Arctic sea and existing sea routes, using a binary logit model. Their results showed that if the total cost of a voyage using the Arctic sea was 70% of the total cost of an existing sea route voyage, and the total period of a voyage using the Arctic sea was 20 days, all demands from the existing sea route would be transferred to the Arctic sea route. Ng (2006) used a multi-logit model to analyse port competitiveness in the European region, especially in the northern part, in Antwerp, Bremen, Felixstowe, Hamburg, Le Havre, and Rotterdam. Lee et al. (2016) analysed the consumer behavior of passengers for transportation modes between domestic and high-speed rail, using a mixed logit model. Jung and Yoo (2016) studied passengers' airport choices in Korea using a hybrid choice

model.

These previous studies can be summarized as follows. The logit model has frequently been used in both the aviation and airport disciplines, particularly with respect to modal choice, measuring demand and the AR. Previous studies relevant to aviation and airports considered flight fares, airport service, and FS as important ACB attributes (Etherington and Var, 1984; Toh and Hu, 1990; Kaynak and Kucukemiroglu, 1993; Fourie and Lubbe, 2006; Hess et al., 20007; Drabas and Wu, 2013). Both Hess et al. (2007) and Drabas and Wu (2013) used the logit model to explore ACB. This study will expand the above models (e.g. Hess et al., 2007) by considering FDD.

3. Research design

In the random utility theory, the utility is not deterministic and is stochastically changeable. Therefore, U_in is a random variable that is organized as a deterministic part (deterministic variable), V_in, and as a stochastically changeable part (random variable), E_in. The former is the utility that can be observed, and the latter is the utility that cannot be observed. The formula can be assumed by the linearity, which can be expressed by the following equation.

$$U_{in} = V_{in} + E_{in} \tag{1}$$

s.t.

U_{in}: The total utility of the individual n's alternative i
V_{in}: The deterministic utility of the individual n's alternative i
E_{in}: The random utility of the individual n's alternative i

The random utility function, V_{in}, can be expressed by the linear equation including the k parameter vector.

$$V_{in} = \beta_1 V_{in1} + \beta_2 X_{in2} + \cdots \beta_k X_{ink} \tag{2}$$

The logit model can be expressed by the following equation, assuming that E_{in} shows Weibull distribution, and each alternative is independently and identically distributed (Ben-Akiva and Lerman, 1985).

$$P_i = \frac{1}{\sum_{j=1}^{i} \exp[-(V_i - V_j)]} = \frac{\exp V_i}{\sum_{j=1}^{i} \exp V_j} \tag{3}$$

According to our literature review in Section 2, flight fares, FS, reliability, and AS are important attributes of ACB, and reliability is closely related to FDD. However, before empirical analysis, we need to define the FDD variable. It can be defined as the amount of time a flight is behind the time scheduled to take off. Consequently, this study considers the attributes of ACB as one-way airfare (OWF), FDD, FS, and AS. The following could give us the detailed definition of each variable.

- *Preferred Airline*: The airline that the passengers will choose in the future. The passenger will choose a Full Service Carriers (FSCs) considering the several attributes of ACB.
- *One-way fare*: One-way airfare between an airport and another airport using FSC or LCC.
- *Flight departure delay times*: The amount of time a flight is behind the time scheduled to take off.
- *Flight service*: The overall service degree including in-flight food and beverage, cabin crew's service attitude, and convenient seat.
- *Available schedule*: The variety of aircraft schedule.

The model can be expressed as the following equations.

$$U_{FA} = \alpha_0 + \alpha_1 OWF + \alpha_2 FDD + \alpha_3 FS + \alpha_4 AS \tag{4}$$

s.t.

U_{FA}: The total utility of the preferred airline
OWF: One-way airfare
FDD: Flight departure delay times
FS: Flight service
AS: Available schedule
α: Coefficient

The SP survey used a binary choice set with 27 attributes, each is presented as mutually exclusive alternatives per respondent. In each choice situation, the respondent was faced with a choice between FSC and LCC. The used 27 attributes were derived from a fractional factorial experimental design that is used to select the most important attributes statistically. Then the respondents were asked to choose the FSC or LCC considering the several attributes of ACB, OWF, FDD, FS, and AS. The attributes and their levels describe the two alternatives in the SP (Table 2). The variable combination of the attributes and their levels could make a binary choice set with 27 mutually exclusive alternatives.

The attribute levels are chosen from several sources; OWF came from the websites of Korean Air and Jin Air, and we inquired the OWF as the one-way airfares from the IIA to Narita airport (NRT). Jin Air's OWF is 117,000 won and Korean Air's OWF is 358,000 from IIA to NRT. The FDD level was extracted from the website of www.airport.co.kr (accessed on 16th June 2016). Basically, FSC could be more competitive than LCC and thus this study considers both FS and AS as middle and high level.

Table 2
Airline choice behvior attributes and their levels

Attribute	Level
One-way airfare (ICN-NRT)	117,000 Korean won (about US$ 102) 358,000 Korean won (about US$ 312)
Flight departure delay times	Less than 1 hour 1–2 hours 2–4 hours More than 4 hours
Flight service	Middle High
Available schedule	Middle High

4. Empirical analysis

The survey for this study was conducted by a Korean specialized survey company, EMBRAIN, through an online survey technique. They targeted passengers who took a flight at the IIA or Gimpo International Airport at least once in the past three years. The survey period was nine days from 7th to 15th June, 2016. The company has many panel profiles, so they sent the survey to their panel lists. The number of their panel profiles was 15,000. A total of 205 questionnaires were collected, and there were 115 valid samples. The responses rate was 0.7%. The respondents' profiles are

as follows, visualizing the nominal scale. Figure 1 displays the number of male and female respondents, and Figure 2 shows the purpose of the flights taken.

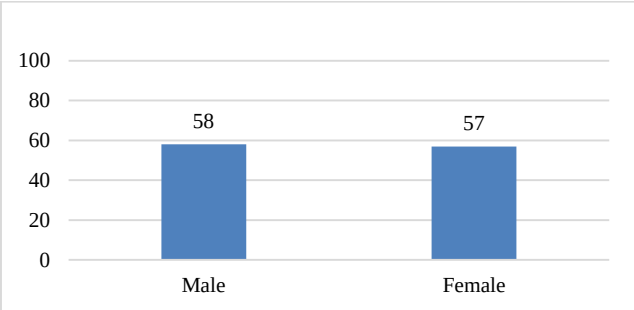

Fig. 1. Profile of gender of respondents

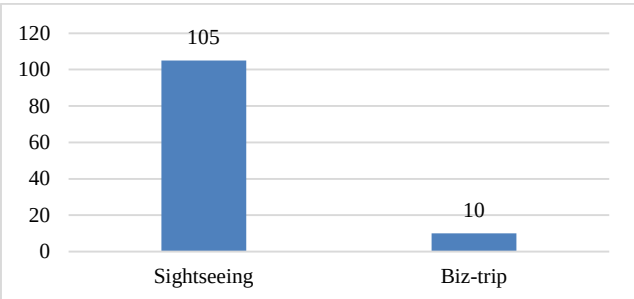

Fig. 2. Purpose of taking a flight

The summary of the selected airlines of respondents is shown in Figure 3. Most respondents prefer the Korean Air (58 respondents) and Asiana Airlines (34 respondents). The total number of respondents who prefer LCCs more than FSCs was 23.

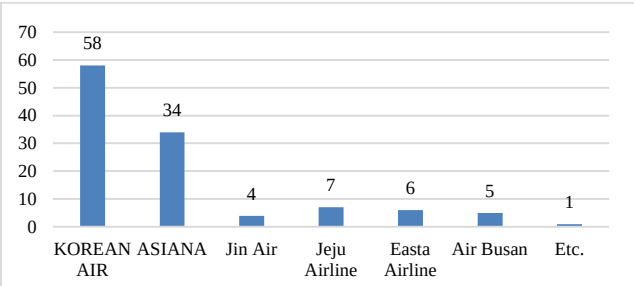

Fig. 3. Profile of respondents' preferred airlines

The descriptive analysis results are shown in Table 3.

Table 3

Descriptive analysis results for respondents

Variable	Samples	Min	Max	Mean	Standard derivation
Age	115	21	69	44.41	13.94
The mean value of taking a flight in recent 3 years	115	2	5	3.12	0.839

The cross-tabulation analysis results are shown in Tables 4, 5, 6, and 7. Since the Pearson Chi-squared statistics in Table 4 is 7.272 and its significant probability is 0.296, the two variables of male and female are independent of each other.

Table 4

Cross-Tabulation analysis between gender and preferred airlines

Gender	Korean Air	Asiana Airlines	Jin Air	Jeju Air	Eastar Jet	Air Busan	Others	Total
Male	30	20	3	2	1	2	0	58
Female	28	14	1	5	5	3	1	57

Note: Chi-squared statistics = 7.272 with p-value = 0.296

Table 5 shows the cross-tabulation analysis results for the age and the preferred airline. The Pearson Chi-squared statistics is 34.917, and its significant probability is 0.070. Therefore, the older the passenger, the more the passenger prefers FSC than LCC.

Table 5

Cross-Tabulation analysis between age and preferred airlines

Age	Korean Air	Asiana Airlines	Jin Air	Jeju Air	Eastar Jet	Air Busan	Others	Total
20s	7	5	2	4	3	0	1	22
30s	11	5	1	1	2	3	0	23
40s	12	6	1	2	1	0	0	22
50s	14	8	0	0	0	2	0	24
60s	14	10	0	0	0	0	0	24

Note: Chi-squared statistics = 34.917 with p-value = 0.070

Table 6 shows the cross-tabulation analysis results for the mean value of taking a flight in the recent three years and the preferred airline. In line with the results in Table 5, the more often passengers take a flight, the more they prefer FSC than LCC. The Pearson Chi-squared statistics is 28.967, and its significant probability is 0.049.

Table 6

Cross-Tabulation analysis between number of flights in recent 3 years and preferred airlines

Number of flights in recent 3 years	Korean Air	Asiana Airlines	Jin Air	Jeju Air	Eastar Jet	Air Busan	Others	Total
1	11	7	0	2	2	0	0	22
2-5	36	19	4	4	4	2	0	69
6-10	6	3	0	0	0	3	0	12
More than 10	5	5	0	1	0	0	1	12

Note: Chi-squared statistics = 28.967 with p-value = 0.049

Table 7 shows the cross-tabulation analysis between the purpose of taking a flight and the preferred airline. There is a dependent relationship between the two variables. The Pearson Chi-squared statistics is 2.793, and its significant probability is 0.834.

Table 7
Cross-Tabulation analysis between purpose of taking a flight and preferred airlines

Purpose of taking a flight	Korean Air	Asiana Airlines	Jin Air	Jeju Air	Eastar Jet	Air Busan	Others	Total
Sightseeing	52	30	4	7	6	5	1	105
Biz-trip	6	4	0	0	0	0	0	10

Note: Chi-squared statistics = 2.793 with p-value = 0.834

The fitness of the SP analysis is confirmed by -2 log likelihood (-2LL) of 2916.616, Cox and Snell R^2 of 0.111, and Nagelkerke R^2 of 0.170. Table 8 shows the SP analysis results. In terms of sufficient probability, all variables excluding one-way airfare are statistically significant at $p < 0.05$.

Table 8
Stated Preference Analysis Results

Variable	Beta	S. E.	Wald statistics	Degree of freedom	Significant probability	Exp (B)
One-way airfare	-0.112	0.114	0.966	1	0.326	0.894
Flight departure delay	-0.378	0.053	50.031	1	0.000	0.686
Flight service	1.104	0.101	120.460	1	0.000	3.017
Available schedule	1.043	0.109	91.267	1	0.000	2.839
Constant	-3.383	0.470	51.871	1	0.000	0.034

Based on the above results, this study sets up the current situation for ACB, as shown in Table 9. The set situations are validated through aviation experts who worked at Korea Transport Institute, Hanjin Logistics Institute, and Korean Airports Corporation. We assume that LCCs' FDD is 1–2 hours, and that both FS and AS are at a middle level, the FSCs' FDD is less than 1 hour, and both FS and AS are at high levels. As a result, the AR of FSCs is 85.3%, and that of LCCs is 14.7%.

Table 9
Current Situation for Airline Choice Behavior

	Flight departure delay times	Flight Service	Available Schedule	Allotment Rate
FSC	Less than 1 hour	High	High	85.3%
LCC	1 ~ 2 hours	Middle	Middle	14.7%

5. Conclusion

Due to the 1988 Seoul Olympics and the overseas tourism freedom policy of 1989, the Korean aviation industry has developed in numerous ways. The KAI shrunk somewhat due to the 1997 International Monetary Fund (IMF) financial crisis in Korea, but since then, it has experienced a great deal of growth, because of the Incheon International Airport's opening in 2001 and the entry of low-cost carriers into the KAI market. However, along with the KAI's considerable growth, FDDs have increased six-fold during the recent decade in Korea.

This paper has added the FDD variable to the airline choice behavior model and has analyzed the extent to which FDD affects ACB.

Descriptive analysis has showed that the importance of FDDs is relatively lower than other ACB attributes. Both flight service and available schedule are positively related to ACB. The more often passengers take a flight and the older they are, the more they prefer full-service carriers over low-cost carriers. This result suggests that most passengers consider the safety factor to be the most important of the ACB attributes.

The AR analysis shows that the AR of FSC is 85.3%, while the rate for LCC is 14.7%. This result is in line with the descriptive analysis, which shows that most passengers consider the safety factor important. It is because most people consider LCC is more dangerous than FSC in general. The empirical results are associated with several tragic aviation accidents including TARAOM Flight 371, Aero Flight 311, and Indonesia AirAsia Flight 8501.

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