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Title：“Can LCC survive in the long-haul market?: Consideration from the perspective of consumer preference”

Authors：J. Mizutani, Y. Ueda and N. Fujii

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６．学会への関わり状況：報告 1 本
７．その他：研究報告・意見交換のみならず，最新の研究動向に関する情報収集も含め，今後の研究の展開に大変有益な学会参加となった．
最後に，当基金からのご支援に心より感謝申し上げます．

Can LCC survive in the long-haul market?: Consideration from the perspective of consumer preference

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Abstract

This study considered the conditions that long-haul LCCs could survive by two approaches, vertical differentiation model analysis and consumer questionnaire survey. Combining the results of both approaches, we can understand that FSCs and LCCs would be compatible on short- and medium-haul routes, especially on the routes with sufficient business demand. On the other hand, long-haul operators would converge with FSCs and it would be difficult for LCCs to survive. Therefore, for long-haul LCCs to succeed, they should be a hybrid of LCCs and FSCs, and providing wider seats could be effective for their hybridization strategies.

Keywords

Long-haul LCC, Vertical differentiation, Questionnaire survey, Conjoint analysis

1. Introduction

COVID-19 has brought about various structural changes in our way of life. One of the most representative changes is the increase in online meetings in business. As a result, business demand of air transport in post-COVID is not expected to recover to that in pre-COVID. On the other hand, leisure demand is expected to recover and grow, thus the presence of leisure demand will increase in the air transport market (ex. Suau-Sanchez et al. 2020).

In response to these demand structure changes, both JAL (JL) and ANA (NH) in Japan have drawn up group growth strategies using their subsidiary LCCs, which are strong in capturing leisure demand with their low fare as shown as a business portfolio in Figure 1. Especially, we should focus on the long-haul LCCs. ZIPAIR Tokyo (ZG), a newly established LCC by JL launched its flights from NRT to BKK in June 2020 and is increasing its destinations to Southeast Asia, West Coast of North America and Hawaii. Air Japan (NQ), a subsidiary of NH, changed its business model from FSC into a hybrid between FSC and LCC, and launched its flights from NRT to BKK in February 2024. Peach (MM), another subsidiary LCC of NH, launched its flights from KIX to BKK in December 2022 with new long-haul aircrafts, A321LRs.

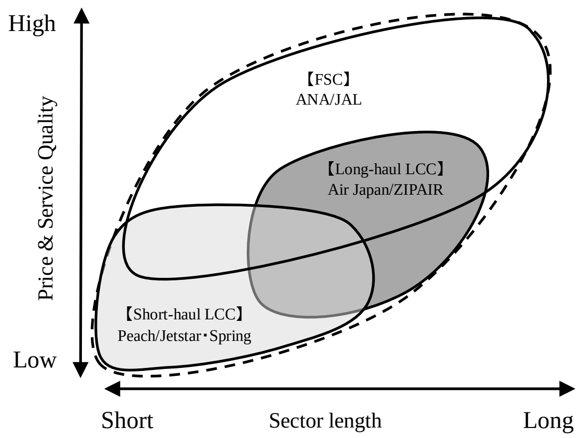

Fig.1 Portfolio of airline business after COVID-19

Note) ANA groups are ANA, Peach and Air Japan.
JAL groups are JAL, Jetstar Japan, Spring Japan and ZIPAIR Tokyo.

The LCC business of ANA and JAL groups began with MM and Jetstar Japan (GK), respectively and they entered into the domestic and short-haul international routes in 2012. Mizutani and Sakai (2021) found that both groups have succeeded in creating new passengers with avoiding and reducing cannibalization between the parent FSC and the subsidiary LCC. In post-COVID, LCC business targeting long-haul international flights begins in earnest. However, we cannot find many successes of the long-haul LCC business worldwide. There some researches considering the reasons why long-haul LCC business is difficult, however, most of them focused on supply side issues such as costs and network (ex. Doganis 2019, Morrell 2008). We would therefore like to add some implications on the business model of long-haul LCCs from the perspective of demand side, consumer preference.

2. Is the long-haul LCC business difficult?

2.1 Smaller cost advantage of LCC over FSC

Several LCCs tried to enter into the long-haul market in the 2000s. Table 1 lists the long-haul LCCs, however, the pioneers, Zoom and Oasis Hong Kong Airlines, went bankrupt after a short period, and several others withdrew during the COVID-19 pandemic. Norwegian has also withdrawn from transatlantic routes. Meanwhile, some of Norwegian's former management started Norse Atlantic as a long-haul LCC. Thai AirAsia X filed a rehabilitation plan with the Central Bankruptcy Court of Thailand in 2022. Additionally, Table 2 shows that long-haul AirAsia X (D7) was in the red before COVID-19, while short-haul AirAsia (AK) was profitable before COVID-19.

Table 1 Long-haul LCCs that exists or have existed

Area	Country	Long-haul LCC	Parent Airline	Operating Periods for Long-haul Routes
Asia	Japan	Air Japan[1]	ANA	2024-
		ZIPAIR Tokyo	JAL	2020-
	Korea	Air Premier[1]	–	2021-
	Hong Kong	Oasis Hong Kong	–	2006-2008
	Malaysia	AirAsia X	AirAsia	2007-
	Thailand	Thai AirAsia X[2]	AirAsia X	2013-
		Nok Scoot	Nok Air & Scoot	2015-2020
	Singapore	Scoot	Budget Aviation Holdings (Singapore Airlines)	2012-
	Indonesia	Indonesia AirAsia X	AirAsia X	2013-2019
Oceania	Australia	Jetstar	Qantas	2006-
Europe	UK	Norwegian UK	Norwegian	2017-2021
	Norway	Norwegian Long-haul	Norwegian	2013-2021
		Norse Atlantic	–	2022-
	Germany	Eurowings	Lufthansa	2015-
	Spain	Level	International Airlines Group (BA & Iberia)	2017-
	France	Joon	Air France	2017-2019
North America	Canada	Zoom	–	2004-2008
		Air Canada Rouge	Air Canada	2013-

Note 1) Air Japan and Air Premier call themselves as hybrid airlines between FSC and LCC.
2) Thai AirAsia X filed for corporate reorganization proceedings with the Central Bankruptcy Court of Thailand in May 2022.

Why is the long-haul LCC business so difficult? One answer can be found in the cost structure of long-haul LCCs (Doganis 2019, Morrell 2008). Figure 1 shows the relationship between average sector length and unit costs, where × is for FSCs and △ for LCCs. We can find that the longer the sector length, the lower the unit costs for both FSCs and LCCs. However, a comparison between D7 and its parent AK shows that the unit costs of D7 is lower than those of AK only by 10%, despite average sector length of D7 is four times that of AK. When comparing the unit costs between the airlines which have approximately the same average sector length, AK is lower than American Airlines (AA) by 60%, while D7 is lower than Singapore Airlines (SQ) by only 46%. Thus, the longer the sector length, the smaller the cost advantage of LCCs over FSCs. One of the factors that generates a cost advantage for LCCs is the achievement of high productivity of aircraft and crew by minimizing turnaround times at the airports. An aircraft of short haul LCC may turn around at the airport several times a day, whereas that of long-haul LCC may turn around once or twice at most. Therefore, on long-haul routes, there are fewer opportunities for LCCs to enjoy this cost advantage than on short-haul routes.

Table 2 Operating Profit of AirAsia and AirAsia X

(million MYR)		2018	2019	2020	2021
Air Asia (AK)	Operating revenue	11,832	12,509	3,617	1,948
	Operating cost	10,613	11,785	9,039	4,793
	Operating profit	1,219	725	△5,422	△2,846
Air Asia X (D7)	Operating revenue	4,579	4,274	1,223	
	Operating cost	4,783	4,395	33,914 (25,163 of which is a contract cancellation penalty)	
	Operating profit	△204	△120	△32,691 (△7,528 excluding contract cancellation penalty)	

Note) Fiscal year is from 1st January to 31st December.
However, 2020 fiscal year of D7 is from 1st January 2020 to 30th June 2021.
Source) Annual report of each company

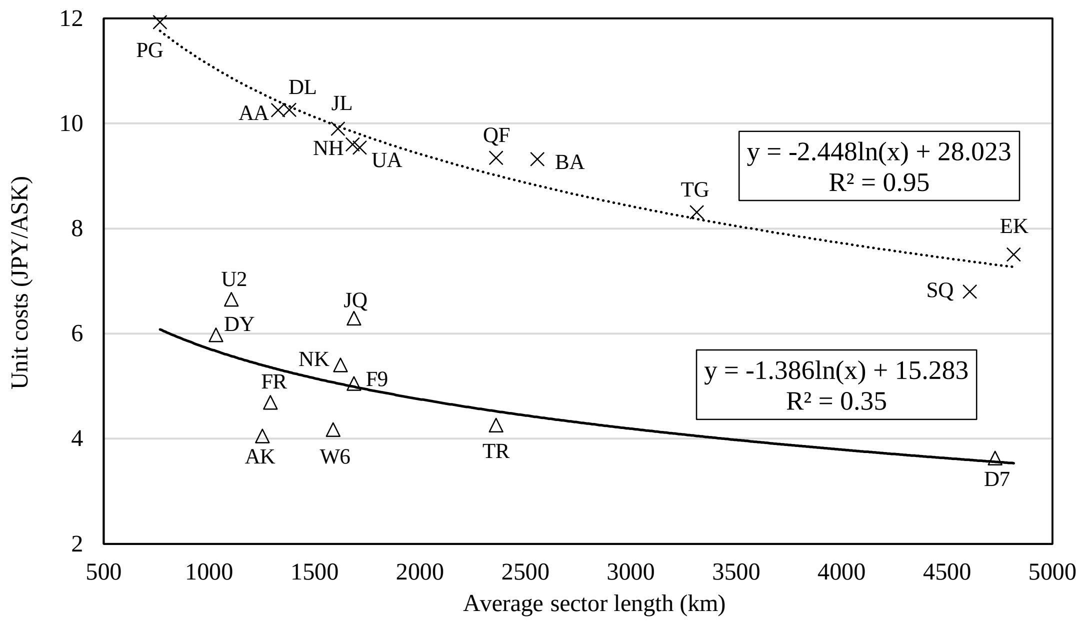

Fig. 2 Average sector length and unit costs (2018)

Note) × and △ mean FSC and LCC, respectively. The data of NK and F9 are in 2019.
Source) Annual report of each airlines and OAG

On the other hand, the new A321LR/XLR aircraft, with a flight range of 7,400 km/8,700 km respectively, are currently attracting attention and expected as a game changer for the success of long-haul LCCs. These aircraft are long-haul versions of the A320 used by many LCCs worldwide, enabling LCCs to operate longer distances with lower pilot training and aircraft maintenance costs. In Japan, MM and GK have already introduced some A321LRs and both airlines would expand their long-haul routes with these aircraft. Another game changer is the B787, which has contributed to expand long-haul LCC routes worldwide due to its fuel efficiency. In Japan, it has been operated by ZG and Air Japan.

2.2 New revenue sources for long-haul LCCs compared to short-haul LCCs

One of the new revenue resource is passengers transferring from LCC to LCC. It is pointed out that feeder effects by short-haul LCCs are important in attracting long-haul LCC passengers (Doganis 2019, Morrell 2008). Actually, some long-haul LCCs focus on connecting passengers. For example, ZG flies from NRT to Southeast Asia and North America, and tried to capture the demand for connecting passengers between Southeast Asia and North America, which has been transported by FSCs. Figure 3 shows the number of passengers from BKK to LAX via NRT from January 2021 to October 2022, extracted from the OAG database. We can find that 20% of passengers chose ZG in summer 2022.

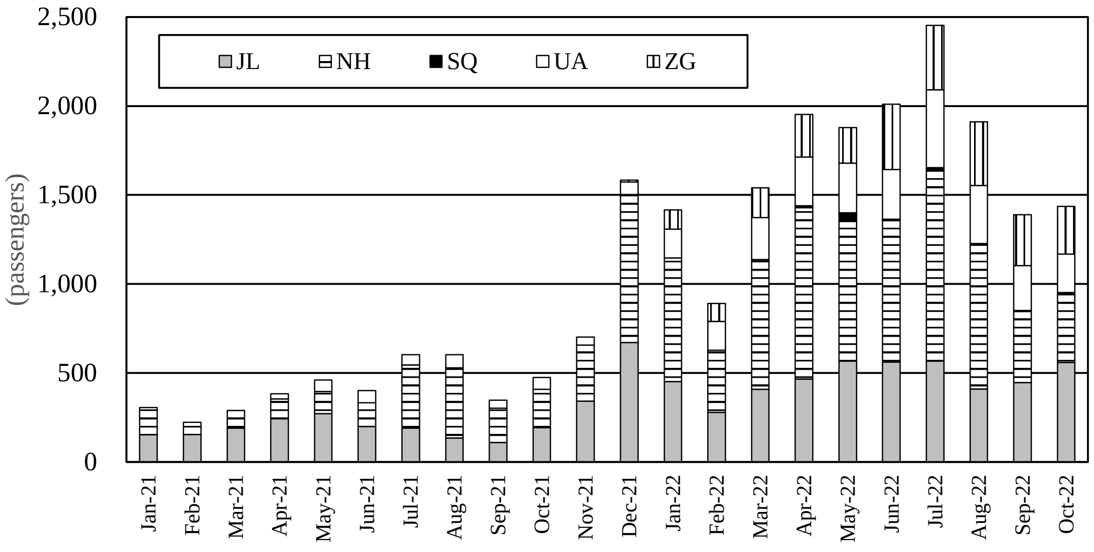

Fig.3 Number of passengers from BKK to LAX via NRT

Note) Airline code represents the airline the passenger boarded from NRT to LAX.
Source) OAG

Another revenue resource is air cargo. The business model of traditional short-haul LCC has given up to handle air cargo except for checked baggage, since the most popular aircrafts, B737 and A320 do not have enough space for air cargoes. Additionally, LCCs want to avoid longer turnaround times at the airports due to cargo handling. However, the cargo space on the B787, operated by many long-haul LCCs, is large enough, and long-haul LCCs do not need as short turnaround times as short-haul LCCs, since they do not fly as many flights per day. For example, ZG's cargo revenues accounted for 27% of its total revenues in 2022 as shown in Table 3. However, we should note that ZG and its parent airline, JL, code-share for cargoes, while they do not do for passengers, and all of ZG's cargo space is purchased by JL. ZG chose to rely on JL to sell its cargo space and not to have its own cargo sales team.

Table 3 Operating Revenue of ZIPAIR Tokyo

(Million JPY)		2020	2021	2022
Operating Revenue	Passenger[1]	52	717	22,449
	Cargo[1]	1,981	6,104	8,580
	Other	5	55	705
	Total	2,038	6,876	31,734

Note1) Revenues from checked baggage are included not in Cargo but in Passenger.
Source) Annual report of ZIPAIR

3. Can LCC survive in the long haul-market?: Model analysis

3.1 The models

In this section, we try to extend the Tirole's vertical differentiation model and apply to the airline market in order to investigate whether LCC can survive in the long-haul-market. Suppose that there are two independent firms called H and L, and H and L produce the high and low quality products, respectively. Our purpose is to identify quality strategies that maximize their profits. We assume the following assumptions according to Tirole (1988).

Assumption 1: i) Firm H and L choose the quality S_h and S_l, and the price P_h and P_l, respectively. Here, $S_h > S_l > 0$ and $P_h > P_l > 0$ are assumed. We should note that the firms decide in order of their qualities, their prices. ii) We define degree of consumer's preference for quality as θ and it is uniformly distributed on the interval $[\theta_l, \theta_h]$, where $\theta_h > \theta_l \geq 0$. iii) Let u_h and u_l be net benefits of consumers when they consume the products of the firm H and L, respectively. Then the net benefits are described as;

$$u_h = \theta S_h - P_h, \quad u_l = \theta S_l - P_l$$

iv) Consumers purchase at least one unit of goods in the market. v) Firm H and L must sell at least one unit of goods in the market.

The preference of indifferent consumers with respect to quality θ_{hl} is described as

$$\theta_{hl} = \frac{P_h - P_l}{S_h - S_l}$$

which comes from $u_h = u_l$. The conditions iv) and v) in Assumption 1 give

$$\theta_l S_l - P_l \geq 0 \qquad (1)$$

and

$$\theta_l < \theta_{hl} < \theta_h.$$

Then we can define demand functions of firm H and L as follows, respectively and illustrate these assumptions in Figure 4.

$$D_h = \theta_h - \frac{P_h - P_l}{S_h - S_l}, \qquad D_l = \frac{P_h - P_l}{S_h - S_l} - \theta_l$$

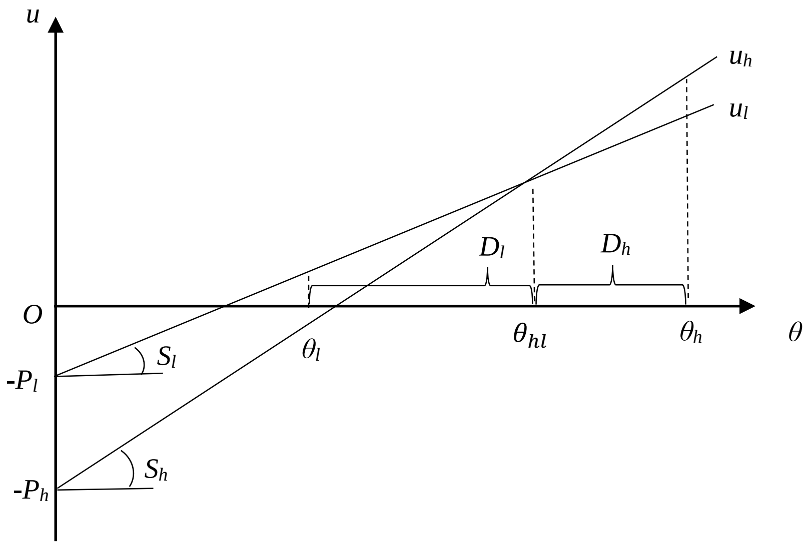

Fig. 4 Distribution of consumer preferences for product quality, and demand for the products

Assumption 2: The marginal costs of firm H and L are defined as C_h and C_l, respectively ($C_h > C_l$), while Tirole (1988) assumed their marginal costs are identical. We assume that their marginal costs are constant with reference to the quantity of their production and their fixed costs are zero.

Assumption 3: The marginal costs of firm H and L are defined as $C(S_h)$ and $C(S_l)$, respectively, where C is a smooth function. As same as the assumption 2, we assume that these marginal costs are constant with reference to the quantity of their production and their fixed costs are zero.

Note that there is no inclusion relation between Assumption 2 and 3. We shall analyze the behavior of each firm under the assumption 2 and 3 in the following sections.

3.2 Analysis in Assumption 2 on costs

To proceed our analysis, profit functions are defined as $\pi_j = \left(P_j - C_j\right)D_j$ for $j = h, l$. We remark that

$$P_j - C_j > 0 \qquad (2)$$

for $j = h, l$ because of $\pi_j > 0$. The profit functions have exact representations that

$$\pi_h = (P_h - C_h)\left(\theta_h - \frac{P_h - P_l}{S_h - S_l}\right), \qquad \pi_l = (P_l - C_l)\left(\frac{P_h - P_l}{S_h - S_l} - \theta_l\right). \qquad (3)$$

Here note that π_j is regarded as the function of P_j and S_j. The first-order conditions for π_j with reference to the prices are described as

$$\frac{\partial \pi_h}{\partial P_h} = 0, \qquad \frac{\partial \pi_l}{\partial P_l} = 0, \qquad (4)$$

and these give

$$\theta_h - \frac{P_h - P_l}{S_h - S_l} - \frac{P_h - C_h}{S_h - S_l} = 0, \qquad \frac{P_h - P_l}{S_h - S_l} - \theta_l - \frac{P_l - C_l}{S_h - S_l} = 0. \qquad (5)$$

Thus, combining the equations in (5), we obtain the reaction functions, P_h^* and P_l^* for the firms H and L as follows;

$$P_h^* = \frac{1}{3}\{2C_h + C_l + (S_h - S_l)(2\theta_h - \theta_l)\}, \qquad P_l^* = \frac{1}{3}\{C_h + 2C_l + (S_h - S_l)(\theta_h - 2\theta_l)\}. \qquad (6)$$

Inspired by the condition (2), we also assume

$$P_j^* - C_j > 0 \qquad (7)$$

for $j = h, l$. Namely, this gives

$$\max\{0, 2\theta_l - \theta_h\} < E(S_h, S_l) < 2\theta_h - \theta_l \qquad (8)$$

where $E := (C_h - C_l)/(S_h - S_l)$. Similarly, inspired by (1), we also assume that

$$\theta_l S_l - P_l^* \geq 0$$

and this means

$$(\theta_h + \theta_l)S_h \geq C_h + 2C_l + (\theta_h - 2\theta_l)S_h$$

We substitute (6) into (3) to obtain

$$\pi_h^* := \pi_h|_{P_h = P_h^*, P_l = P_l^*}$$

$$= \frac{1}{9}\left\{(S_h - S_l)(2\theta_h - \theta_l)^2 + \frac{(C_h - C_l)^2}{S_h - S_l} - 2(C_h - C_l)(2\theta_h - \theta_l)\right\}, \qquad (9)$$

$$\pi_l^* := \pi_l|_{P_h = P_h^*, P_l = P_l^*}$$

$$= \frac{1}{9}\left\{(S_h - S_l)(\theta_h - 2\theta_l)^2 + \frac{(C_h - C_l)^2}{S_h - S_l} + 2(C_h - C_l)(\theta_h - 2\theta_l)\right\}. \qquad (10)$$

Therefore, we get the marginal change of the profit caused by the marginal increase of quality for each firms as follows;

$$\frac{\partial \pi_h^*}{\partial S_h} = \frac{1}{9}\{2\theta_h - \theta_l - E(S_h, S_l)\}\{2\theta_h - \theta_l + E(S_h, S_l)\}, \qquad (11)$$

$$\frac{\partial\pi_l^*}{\partial S_l} = \frac{1}{9}\{E(S_h,S_l) - (\theta_h - 2\theta_l)\}\{E(S_h,S_l) + \theta_h - 2\theta_l\}. \qquad (12)$$

Since (8), we obtain that[1]

$$\frac{\partial\pi_h^*}{\partial S_h} > 0 \qquad (13)$$

and

$$\begin{aligned} &\frac{\partial\pi_l^*}{\partial S_l} > 0 \quad \text{if} \quad E(S_h,S_l) - (\theta_h - 2\theta_l) > 0, \\ &\frac{\partial\pi_l^*}{\partial S_l} = 0 \quad \text{if} \quad E(S_h,S_l) - (\theta_h - 2\theta_l) = 0, \qquad (14) \\ &\frac{\partial\pi_l^*}{\partial S_l} < 0 \quad \text{if} \quad E(S_h,S_l) - (\theta_h - 2\theta_l) < 0. \end{aligned}$$

Consequently, we conclude the followings.

(i) Case $\theta_h - 2\theta_l > 0$;

$$\text{(i-i)} \ \frac{\partial\pi_h^*}{\partial S_h} > 0,\ \frac{\partial\pi_l^*}{\partial S_l} > 0 \quad \text{if} \quad E(S_h,S_l) > \theta_h - 2\theta_l$$

$$\text{(i-ii)} \ \frac{\partial\pi_h^*}{\partial S_h} > 0,\ \frac{\partial\pi_l^*}{\partial S_l} = 0 \quad \text{if} \quad E(S_h,S_l) = \theta_h - 2\theta_l$$

$$\text{(i-iii)} \ \frac{\partial\pi_h^*}{\partial S_h} > 0,\ \frac{\partial\pi_l^*}{\partial S_l} < 0 \quad \text{if} \quad 0 < E(S_h,S_l) < \theta_h - 2\theta_l$$

(ii) Case $\theta_h - 2\theta_l < 0$;

$$\frac{\partial\pi_h^*}{\partial S_h} > 0,\ \frac{\partial\pi_l^*}{\partial S_l} > 0$$

We try to apply the above results to air transport market. Case (i) represents that the distribution of consumer's preference with reference to quality is wide and the medium-haul market would be suitable for this case as shown in Figure 1. In the case of (i-i), both of the firm H and L would be identical as FSCs, since both firms can increase their profits by offering higher quality products. In the case of (i-iii), the firm H would become an FSC, while the firm L would become an LCC, since firm H can increase its profit by offering higher quality products, while firm L can increase its profit by offering lower quality products. The case of (i-ii) is a threshold between the cases of (i-i) and (i-iii). Additionally, the cases of (i-iii) is same as Tirole's case.

Case (ii) represents that the distribution of consumer's preference with reference to quality

[1] If we replace (7) to $P_j^* - C_j \geq 0$, (13) is replaced as $\frac{\partial\pi_h^*}{\partial S_h} \geq 0$. The condition (14) is also same situation.

is narrow and the short- and long-haul markets would be suitable for this case as shown in Figure 1. In this case, both of the firm H and L would be identical as higher quality firms, since both firms can increase their profits by offering higher quality products. Therefore, both firms would be FSCs if consumers require relatively higher quality service, while they would be LCCs if consumers require relatively lower quality service. Long-haul routes are considered to apply to the former case and short-haul routes to the latter. Tirole did not consider this case, since his model assumed $\theta_h - 2\theta_l > 0$.

3.3 Analysis in Assumption 3 on costs

Using the same argument as in Section 3.2, we shall derive the behavior of the firm H and L. Profit functions are also defined as $\pi_j = \big(P_j - C(S_j)\big)D_j$ and we assume that

$$P_j - C(S_j) > 0 \qquad (15)$$

for $j = h, l$. Then the profit functions of each firm are described as

$$\pi_h = (P_h - C(S_h))\left(\theta_h - \frac{P_h - P_l}{S_h - S_l}\right), \quad \pi_l = (P_l - C(S_l))\left(\frac{P_h - P_l}{S_h - S_l} - \theta_l\right). \qquad (16)$$

Using (4), we obtain the reaction functions, P_h^* and P_l^* for the firms H and L as follows;

$$P_h^* = \frac{1}{3}\{2C(S_h) + C(S_l) + (S_h - S_l)(2\theta_h - \theta_l)\},$$
$$P_l^* = \frac{1}{3}\{C(S_h) + 2C(S_l) + (S_h - S_l)(\theta_h - 2\theta_l)\}. \qquad (17)$$

Inspired by the condition (15), we assume

$$P_j^* - C(S_j) > 0 \qquad (18)$$

for $j = h, l$. Namely, this gives

$$\max\{0, 2\theta_l - \theta_h\} < F(S_h, S_l) < 2\theta_h - \theta_l \qquad (19)$$

where $F := (C(S_h) - C(S_l))/(S_h - S_l)$. Similarly, inspired by (1), we also assume that

$$\theta_l S_l - P_l^* \geq 0$$

and this means

$$(\theta_h + \theta_l)S_h \geq C_h + 2C_l + (\theta_h - 2\theta_l)S_h$$

We substitute (17) into (16) to obtain

$$\pi_h^* := \pi_h|_{P_h = P_h^*, P_l = P_l^*}$$
$$= \frac{1}{9}\left\{(S_h - S_l)(2\theta_h - \theta_l)^2 + \frac{(C(S_h) - C(S_l))^2}{S_h - S_l} - 2(C(S_h) - C(S_l))(2\theta_h - \theta_l)\right\}, \qquad (20)$$

$$\pi_l^* := \pi_l|_{P_h = P_h^*, P_l = P_l^*}$$
$$= \frac{1}{9}\left\{(S_h - S_l)(\theta_h - 2\theta_l)^2 + \frac{(C(S_h) - C(S_l))^2}{S_h - S_l} + 2(C(S_h) - C(S_l))(\theta_h - 2\theta_l)\right\}. \qquad (21)$$

Therefore, we get the marginal change of the profit caused by the marginal increase of quality for each firms as follows;

$$\frac{\partial \pi_h^*}{\partial S_h} = \frac{1}{9}\{2\theta_h - \theta_l - F(S_h, S_l)\}\{2\theta_h - \theta_l + F(S_h, S_l) - 2C'(S_h)\}, \qquad (22)$$

$$\frac{\partial \pi_l^*}{\partial S_l} = \frac{1}{9}\{F(S_h, S_l) - 2C'(S_l) - (\theta_h - 2\theta_l)\}\{F(S_h, S_l) + \theta_h - 2\theta_l\}. \qquad (23)$$

Since (19), we obtain that

$$\frac{\partial \pi_h^*}{\partial S_h} > 0 \quad \text{if} \quad 2\theta_h - \theta_l + F(S_h, S_l) - 2C'(S_h) > 0,$$

$$\frac{\partial \pi_h^*}{\partial S_h} = 0 \quad \text{if} \quad 2\theta_h - \theta_l + F(S_h, S_l) - 2C'(S_h) = 0, \qquad (24)$$

$$\frac{\partial \pi_h^*}{\partial S_h} < 0 \quad \text{if} \quad 2\theta_h - \theta_l + F(S_h, S_l) - 2C'(S_h) < 0,$$

and

$$\frac{\partial \pi_l^*}{\partial S_l} > 0 \quad \text{if} \quad F(S_h, S_l) - 2C'(S_l) - (\theta_h - 2\theta_l) > 0,$$

$$\frac{\partial \pi_l^*}{\partial S_l} = 0 \quad \text{if} \quad F(S_h, S_l) - 2C'(S_l) - (\theta_h - 2\theta_l) = 0, \qquad (25)$$

$$\frac{\partial \pi_l^*}{\partial S_l} < 0 \quad \text{if} \quad F(S_h, S_l) - 2C'(S_l) - (\theta_h - 2\theta_l) < 0.$$

Let S_h^* and S_l^* be equilibrium points for the quantities of firms H and L, that is,

$$G_h(S_h^*, S_l^*) = 0, \; G_l(S_h^*, S_l^*) = 0 \qquad (26)$$

where

$$G_h(S_h, S_l) \coloneqq (2\theta_h - \theta_l) + F(S_h, S_l) - 2C'(S_h), \; G_l(S_h, S_l) \coloneqq F(S_h, S_l) - 2C'(S_l) - (\theta_h - 2\theta_l).$$

Then, because of (24) and (25), we conclude that the equilibrium points S_h^* and S_l^* are stable if

$$\left.\frac{\partial G_h}{\partial S_h}\right|_{S_h = S_h^*, S_l = S_l^*} < 0, \qquad \left.\frac{\partial G_l}{\partial S_l}\right|_{S_h = S_h^*, S_l = S_l^*} < 0. \qquad (27)$$

We can illustrate the above situations for firm H and L as Figure 5a and 5b, and explain that the likelihood that firm H will choose quality up [down] increases when the distribution range of consumer's preference for quality is wide [narrow], since the threshold for quality choice of firm H $(-2\theta_h + \theta_l)$ goes down [goes up]. On the other hand, the likelihood that firm L will choose quality down [up] increases when the distribution range of consumer's preference for quality is wide [narrow], since the threshold for quality choice of firm L $(\theta_h - 2\theta_l)$ goes up [goes down]. Therefore, a wider distribution of consumers with respect to quality makes the two firms more likely to be heterogeneous, while a narrower distribution makes them more likely to be homogeneous.

We could conclude the above model analysis that when the distribution of consumer's preference for service quality is wide, high-quality FSCs and low-quality LCCs are likely to become more heterogeneous, and FSCs and LCCs are likely to be compatible with each other, and the medium-haul market is likely to have such a characteristic. On the other hand, when the distribution range of consumer's preference for service quality is narrow, high-quality FSCs and low-quality LCCs are likely to become more homogeneous and converge to either FSCs or LCCs. The short-haul and long-haul markets are likely to have these characteristics, with short-haul converging to LCCs and long-haul converging to FSCs. According to model analysis, it seems difficult for LCCs to survive in the long haul-market, while they can survive in the short- and medium-haul market.

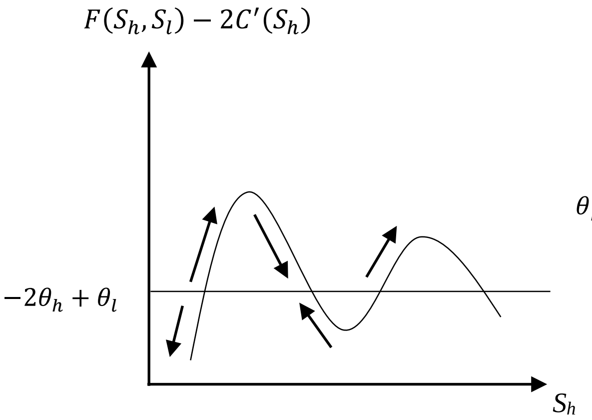

Fig. 5a Quality choice of the firm H

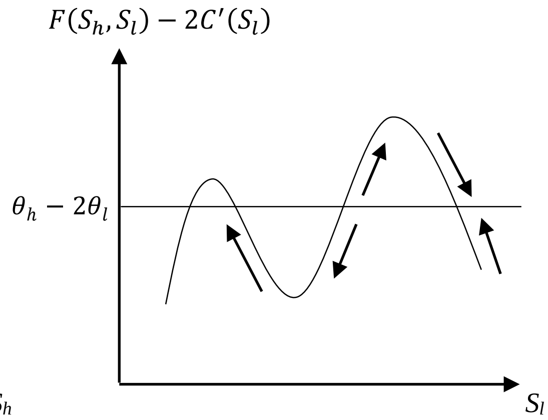

Fig. 5b Quality choice of the firm L

Example: Let a cost function be $C(S) = S^2$. Then the equilibrium points satisfy

$$(2\theta_h - \theta_l) - 3S_h^* + S_l^* = 0, \qquad S_h^* - 3S_l^* - (\theta_h - 2\theta_l) = 0$$

and these give

$$S_h^* = \frac{1}{8}(5\theta_h - \theta_l), \quad S_l^* = \frac{1}{8}(5\theta_l - \theta_h). \qquad (28)$$

On the other hand, we calculate

$$\frac{\partial G_h}{\partial S_h} = \frac{\partial G_l}{\partial S_l} = -3.$$

Consequently, this fact and (27) tell us that the equilibrium points (28) are globally stable[2].
Furthermore, (17) gives

$$P_h^* = \frac{1}{64}(49\theta_h^2 - 58\theta_h\theta_l + 25\theta_l^2),$$
$$P_l^* = \frac{1}{64}(25\theta_h^2 - 58\theta_h\theta_l + 49\theta_l^2).$$

and these also give

$$P_h^* - P_l^* = \frac{3}{8}(\theta_h^2 - \theta_l^2).$$

The above situations for firm H and L could be illustrated as Figure 6a and 6b, respectively. And we can find that as the range of preferences becomes narrower, the price difference between firm H and L becomes smaller according to $\frac{3}{8}(\theta_h^2 - \theta_l^2)$.

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[2] Because of (28), we assume $5\theta_l > \theta_h$.

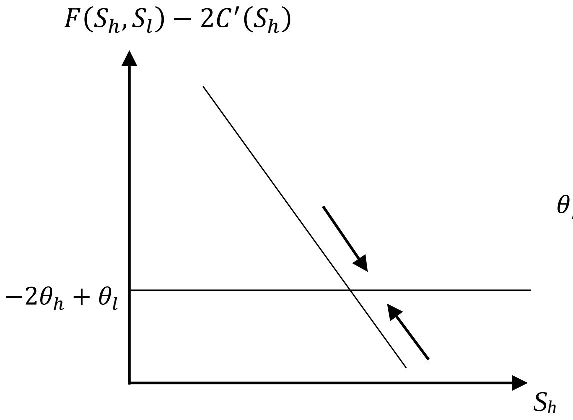

Fig. 6a Quality choice of the firm H

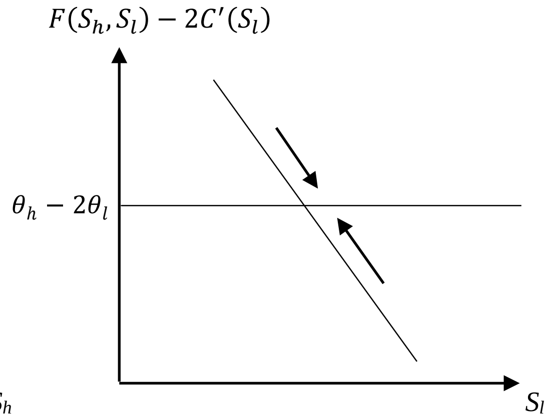

Fig. 6b Quality choice of the firm L

4. Can LCC survive in the long-haul market?: Questionnaire survey

4.1 Importance rating of service quality

We conducted an online consumer questionnaire survey in March 2023 and asked how important the six factors of service (fare, flight frequency, seat [leg space], in-flight meal, in-flight entertainment, and frequent flyer point [FFP]) are. Respondents were 2,000 people from all over Japan who had traveled abroad. Firstly, with reference to trip purpose, 1,000 respondents who had traveled for business answered the survey with imaging business trip and another 1,000 respondents who had traveled for leisure answered with imaging leisure trip. Respondents who had traveled for both business and leisure were randomly assigned to one of the travel purposes. Secondly, each respondent imagined traveling to Seoul for short-haul routes (with 2hour flight), Singapore for medium-haul routes (with 7hour flight), and Frankfurt for long-haul routes (with 12hour flight), and rated the importance of the six factors on a 5-point scale (from 1 not important to 5 very important). That is, each respondent answered in the case of one of the two travel purposes (business or leisure) and all three sector lengths (short, medium, and long).

Figure 7 shows the average importance rating for each service attribute by route distance, with the solid line representing business purpose and dotted line representing leisure purpose. First, a comparison of importance by service attributes shows that the importance of fare and seat are higher, and that of entertainment is lower. Second, a comparison by sector length shows that the importance of fare and frequency are almost constant regardless of route distance, while the importance of seat, meal, entertainment and FFP increase with distance. Finally, a comparison by trip purpose shows that importance of fare for leisure is higher on all sector lengths, while other service attributes for business are higher on all sector lengths, even on short-haul. This result may reflect the fact that, in general, the passenger itself pays the fare for leisure purposes, while the passenger's employer pays the fare for business purposes.

Table 4 shows the differences between the average rating for business purpose minus the average rating for leisure purpose for each service attribute. Differences on fares and FFP are significant for all distances, while differences on frequency, seat, meal and entertainment are significant for short- and medium-haul but not for long-haul. This means that on short- and medium-haul routes there is a difference in preference between leisure and business passengers, while on long-haul routes there is no difference in preference between the two. And if we consider the representative passengers of FSCs and LCCs are business and leisure passengers respectively, FSCs and LCCs might be compatible on short- and medium-haul routes due to the wide range of preferences by passengers, while on long-haul routes, the range of preferences is narrower, so the convergence towards high-quality FSCs would occur and LCCs could not survive. Finally, focusing on FFP, it is the least important attribute for medium- and long-haul leisure passengers, so there seems to be no need to offer expensive FFP to them at the expense of the most important fare.

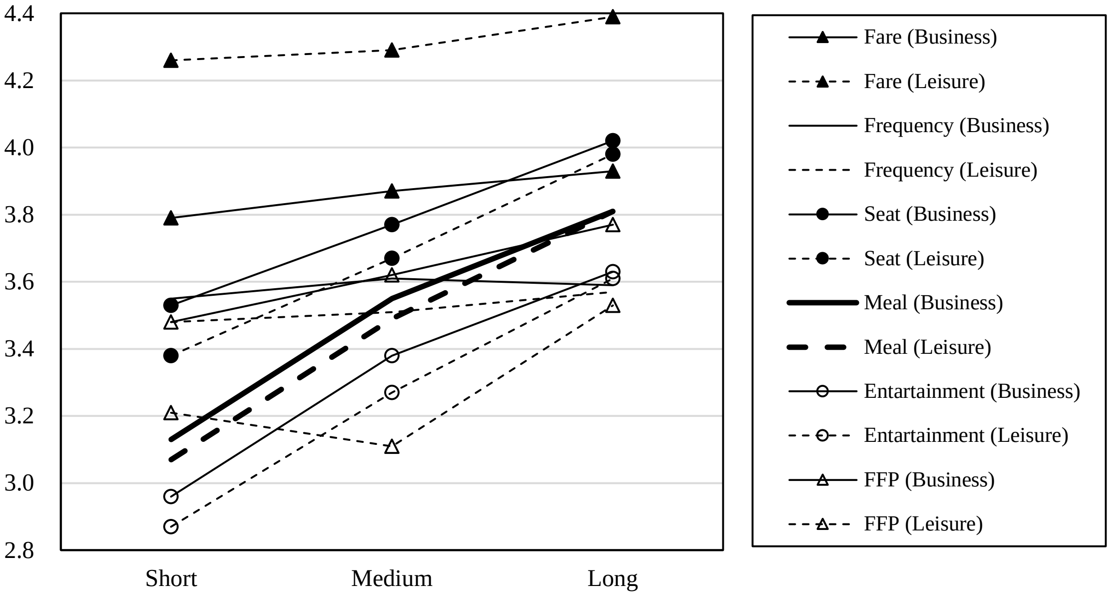

Fig.7 Average of importance rating of service quality

Table 4 Differences of importance rating of service quality (= Business – Leisure)

Service	Short-haul	Medium-haul	Long-haul
Fare	-0.47***	-0.42***	-0.46***
Frequency	0.07***	0.10*	0.02
Seat (Leg Space)	0.15***	0.10***	0.04
Meal	0.06*	0.06	0.00
Entertainment	0.09***	0.11**	0.02
Frequent flyer point (FFP)	0.27***	0.51***	0.24***

Note) *** means significance at 1%, ** at 5%, * at 10%.

4.2 Willingness to pay for service quality

4.2.1 Conjoint analysis

We try to estimate the marginal willingness to pay (MWTP) for the above six services by conducting a choice-based conjoint analysis. The choice-based conjoint analysis developed by Louviere and Woodworth (1983) has an advantage in that to choose the best option among alternatives is similar to consumers' usual behavior. At first, we assume that total utility of a respondent U_j is described by the following equation when the consumer selects the product *j*:

$$U_j = V_j(\boldsymbol{x}_j, p_j) + \varepsilon_j$$

where,

V_j: observable utility when product *j* is selected,

ε_j: unobservable utility,

$\boldsymbol{x}_j$: vector of quality of product *j* (except for price),

p_j: price of product *j*.

Probability P_j that product *j* is selected from among *k* products can be written as the following conditional logit model if ε_j is independently identically distributed and follows the Gumbel distribution as McFadden (1974) demonstrated.

$$P_j = \frac{\exp V_j}{\sum_k \exp V_k} \qquad (29)$$

We specify Equation (30) as a utility function.

$$V(\boldsymbol{x}, p) = \sum_i \beta_i x_i + \beta_p p \qquad (30)$$

where, βs are parameters. We can get Equation (31) by total differentiation of Equation (30).

$$dV = \sum_i \frac{\partial V}{\partial x_i} dx_i + \frac{\partial V}{\partial p} dp \qquad (31)$$

Finally, we can get Equation (32) as MWTP for marginal increase of quality x_1 after fixing the utility *V* and the qualities $\boldsymbol{x}$ except for x_1 at initial value ($dV = 0$ and $dx_1 = 0,\ i \neq 1$).

$$MWTP_1 = \frac{dp}{dx_1} = -\frac{\partial V}{\partial x_1} \Big/ \frac{\partial V}{\partial p} = \frac{\beta_1}{\beta_p} \qquad (32)$$

4.2.2 Estimation of MWTP

We conducted another questionnaire survey to the same 2,000 respondents as the above survey. The service quality was set at four levels for fare and frequency for each destination (sector length), and two levels for seat, meal, entertainment and FFP, regardless of destination as shown in Table 5. The sixteen profiles were prepared by allocating these six qualities on the orthogonal table. On our survey, we showed two profiles from the sixteen choices to the respondents and asked to choose the preferable profile A or B as shown in Table 6. There are 120 combinations of the profiles for each destination (${}_{16}C_2$ = 120), however, we deleted some combinations that did not have a tradeoff relationship among the qualities. 97 combinations were left after deleting those without any tradeoff and we created 20 questionnaire sets with five profile combinations chosen from these combinations for each destination. The 2,000 respondents were asked to answer one questionnaire set for each destination with imagining business or leisure trip based on their previous trip experience as the importance rating survey. Therefore, each respondent who was assigned to a business passenger (1,000 respondents) and a leisure passenger (1,000 respondents) answered 15 questions (one set with five questions multiplied by three destinations). Note that each questionnaire set was randomly delivered to the respondents from the prepared 20 questionnaire sets.

To estimate the conditional logit model by Equations (29) and (30), we defined frequency, seat, meal, entertainment and FFP as the variables $\boldsymbol{x}$ and fare as the variable p. A total of six regressions for two trip purposes and three destinations were executed and the estimation results are shown in Table 7. Note that if one respondent answered A or B for all 15 questions, they were excluded from the data set (121 respondents for business and 163 respondents for leisure were excluded). Table 5 also shows the MWTP for each service, calculated by substituting the estimated parameters into equation (32). We recognized MWTP as zero if the corresponding parameters were insignificant. Additionally, the signs of the significant parameters are all reasonable, negative for fare and positive for other variables.

Focusing on differences of MWTP by trip purpose, we can find that MWTP for increases of flight frequency is generally low and the differences by trip purpose are small. MWTPs for frequency are zero regardless of the trip purpose, especially on long-haul. On the other hand, MWTPs except for frequency are considerably higher for business than for leisure, regardless of distance. As the cost of a business trip is borne by the employer and not by the passenger itself, passengers are likely to prefer high quality, even for short distances. This result is consistent with the results of the importance rating survey.

Furthermore, when MWTPs between in-flight services (seat, meal and entertainment) are compared, that for seat is the highest, followed by meal and entertainment, regardless of trip purpose and distance. The MWTP of entertainment for leisure trip is zero for short- and medium-haul and as low as JPY 9,514 for long-haul, which means that LCCs would not need to be equipped with expensive seat monitors. On the other hand, the leisure passenger's MWTP for meal and wider seat are high especially on medium- and long-haul flights at JPY 15,513 and 32,420 for meals and JPY 26,809 and 42,491 for seats. Hence, if medium- and long-haul LCCs prepare good meals and wider seats, many passengers would find them attractive. Finally, with reference to FFP, the MWTP for leisure trip is less than one third of that for business trips, regardless of distance. For FSCs, it might be a powerful tool to attract business passengers, while LCCs offering FFP would not be so attractive to leisure passengers.

Table 5 Level of service quality for conjoint analysis

Service	Level	
Fare of return ticket (JPY)	SEL	25,000, 37,500, 50,000, 67,500
	SIN	60,000, 90,000, 120,000, 150,000
	FRA	130,000, 180,000, 230,000, 280,000
Frequency per day	SEL	1, 4, 7, 10 flights
	SIN	1, 3, 5, 7 flights
	FRA	1, 2, 3, 4 flights
Seat (Leg Space)	Wide (=1), Narrow (=0)	
Meal	Yes (=1), No (=0)	
Entertainment	Yes (=1), No (=0)	
FFP	Yes (=1), No (=0)	

Table 6 Example of a profile shown to the respondents

Destination	Seoul (with 2 hour flight)	
	A	B
Fare of return ticket (JPY)	37,500	50,000
Frequency per day	7 flights	7 flights
Seat (Leg Space)	Wide	Narrow
Meal	No	Yes
Entertainment	No	No
FFP	No	Yes

Table 7 Estimation Results of MWTP

Destination		Seoul (Short-haul)		Singapore (Medium-haul)		Frankfurt (Long-haul)	
Trip purpose		Business	Leisure	Business	Leisure	Business	Leisure
Fare		-0.000044***	-0.000088***	-0.000017***	-0.000034***	-0.000009***	-0.000019***
Frequency		0.025066***	0.040925***	-0.006406	0.037135***	-0.021687	-0.028838
Seat		0.615341***	0.524988***	0.720250***	0.903455***	0.847458***	0.786091***
Meal		0.355791***	0.148245***	0.455219***	0.522794***	0.519646***	0.599769***
Entertainment		0.123002***	0.027277	0.175603***	0.07877	0.150487***	0.176014***
FFP		0.321268***	0.187021***	0.410584***	0.272214***	0.394085***	0.240271***
Sample size		8,790	8,370	8,790	8,370	8,790	8,370
Log likelihood		-2,694.14	-2,013.06	-2,712.69	-2,146.93	-2,697.35	-2,223.32
Psuedo-R^2		0.12	0.31	0.11	0.26	0.12	0.23
MWTP	Frequency	566	467	0	1,102	0	0
	Seat	13,890	5,986	43,129	26,809	92,517	42,491
	Meal	8,031	1,690	27,529	15,513	56,730	32,420
	Entertainment	2,777	0	10,515	0	16,429	9,514
	FFP	7,252	2,133	24,586	8,078	43,022	12,988

Note) *** means significance at 1%, ** at 5%, * at 10%.

5. Conclusion

This study considered the conditions that long-haul LCCs could survive by two approaches, theoretical model analysis and consumer questionnaire survey on service qualities. Firstly, according to the vertical differentiation model analysis, we found that FSCs and LCCs would be compatible when the range of consumer preferences for quality is wide, on the other hand they would converge on either FSC or LCC when the range is narrow.

Secondly, assuming that business passengers represent high quality (with high price) oriented passengers and leisure passengers represent low price (with low quality) oriented passengers, the results of the questionnaire survey showed that there were many differences in the service quality preferences between business and leisure passengers for short- and medium-haul flights, while there were few differences for long-haul flights. Combining these results with the results of the theoretical model analysis, we can understand that FSCs and LCCs would be compatible on short- and medium-haul routes, especially on routes with sufficient business demand. On the other hand, long-haul operators would converge with FSCs and it would be difficult for LCCs to survive. Therefore, for long-haul LCCs to succeed, they should be a hybrid of LCCs and FSCs.

Finally, we considered hybridization strategies for long-haul LCCs by conducting conjoint analysis with the survey results and found that Long-haul LCCs should offer wider seats at higher prices, as the MWTP for a wider seat is very high even among leisure customers. On the other hand, MWTPs for entertainment and FFP are low and there would be no need to prepare neither in-flight entertainment nor FFP at expensive costs.

Acknowledgement

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References

Doganis, R. (2019) *Flying Off Course, Airline Economics and Marketing* (*5th ed*.), Routledge.

Louviere, J. and Woodworth, G. (1983) “Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data” *Journal of Marketing Research*, Vol. 20, No. 4, pp. 350-367.

McFadden, D. (1974) “Conditional logit analysis of qualitative choice behavior” P. Zarembka (eds.), *Frontiers in Econometrics*, Academic Press, pp. 105-142.

Mizutani, J. and H. Sakai (2021) “Which is a stronger competitor, High Speed Rail, or Low Cost Carrier, to Full Service Carrier?: Effects of HSR network extension and LCC entry on FSC's airfare in Japan”, *Journal of Air Transport Management*, No.90, pp.1-11.

Morell, P. (2008) “Can long-haul low-cost airlines be successful?”, *Research in Transportation Economics*, Vol.24, No.1, pp.61-67.

Suau-Sanchez, P., A. Voltes-Dorta and N. Cuguero-Escofet (2020) “An early assessment of the impact of COVID-19 on air transport: Just another crisis or the end of aviation as we know it?”, *Transport Geography*, Vol.86, pp.1-8.

Tirole, J. (1988) *The Theory of Industrial Organization*, MIT Press.