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Rivalry between low cost carriers and major carriers: the case in Korean aviation industry*

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Abstract

As the wave of liberalization and deregulation have accelerated to relieve rigid controls over airline routes, capacity, and fare setting regimes, Low Cost Carriers (LCCs) have emerged especially in local aviation markets since the 1970s.

This paper has studied the effects of LCC's entry into the domestic aviation market which was pre-occupied by two major carriers, Korean Air (KAL) and Asiana Airlines. Through a simple model describing two situations, prior and post to LCC's entry, we analyzed changes and trends of each airline's output and profit based on the Cournot and two-stage Stackelberg game equilibrium.

In summary, our conclusion consists of five points: (1) Even though JIN Air's entry reduced KAL's respective output and profit, the more JIN Air produces, the higher the joint-profit of KAL and JIN Air is, (2) From the joint-profit aspect, increasing KAL's output to a level than JIN Air's is more profitable on the Gimpo-Jeju route, on the other hand, increasing JIN Air's output higher than KAL's is more profitable on the Jeju-Busan route, (3) Even though JIN Air's entry increase Asiana Airline's output, the more JIN Air produces, the less Asiana Airlines's profit is, (4) Total output in markets as well as total profits of firms will increase under certain conditions, (5) KAL and JIN Air tend to get caught in an unresolved conflict on level of LCC cost.

Key-words: *low cost carrier (LCCs), airline rivalry, local aviation markets, game theory, Stackelberg-Nash equilibrium.*

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1. Introduction

1.1. Research Background

As a promising business model in recent years, Low Cost Carrier (LCC) can be described by two specific characteristics, i.e. low cost and low in-flight service. Minimum legal crew, online booking policies, and fast turn-rounds are conducive to reducing labor and operating costs, which, in turn, lower in-flight services, combined with no freight and point-to-point traffic only policies. From a common sense standpoint, low quality of service can be harmful to a carrier's attraction, however LCCs have achieved remarkable success in creating a new group of travelers for whom price is more important than service.

As the wave of liberalization and deregulation accelerated to relieve rigid controls over airline routes, capacity, and fare setting regime, LCCs have emerged especially in local aviation markets since 1970s. A study by the International Air Transport Association (IATA, 2006) shows that LCCs account for about 10 percent of the world's airline traffic and are continuing to grow rapidly posing a threat to major carriers.

Even though there are slight differences of opinions over when the first phase of LCCs started, Southwest Airline, launched in 1971, is regarded as the pioneer of the domestic LCC model. Other representative LCCs by region are Easy Jet in the United Kingdom, Ryan Air in Ireland, Tiger Air in Singapore, Oasis Air in Hongkong, Air Asia in Malaysia, Virgin Blue in Australia, Skynet Asia in Japan and JIN Air in South Korea.

Table 1.
Key principles of the low-cost carrier model

High-capacity seating, Minimum legal crew
Cabin service only at additional cost, Fast turn-rounds
On-board air stairs instead of airport air bridges
Operating procedures to minimize take-off thrust braking on landing
Point-to-point traffic only, No freight
Advantageous rates from airport operators
Generally sectors of less than 2 hours to maximize aircraft utilization
Online booking to eradicate travel agent commission
Supplements for payment by credit card
Sophisticated web-sites with extensive information on destinations
One-size and type fleets

Source : Brian Graham et al. 2006

Obviously the critical factor of LCCs' growth and success is their cost reduction strategy. According to the Centre for Asia Pacific Aviation (2002), unit cost of LCCs was about 30 percent lower than that of major carriers. By regions, Europe, the USA and Asia showed 59.7 percent, 78.9 percent and 64.6 percent, respectively.

Table 2.
Unit costs comparison of major carriers and LCCs

<Unit : US cents>

	Flag Carriers		LCCs		LCC/Flag
EUROPE	British Airways Air France Lufthansa	12.7 15 17 **14.9***	EasyJet RyanAir Go Fly	10.9 7.1 8.9 **8.9***	59.7%
USA	United American Northwest	11.2 11.3 10.3 **10.9***	Southwest Frontier AirTran	7.3 9.2 9.3 **8.6***	78.9%
ASIA	Singapore Airlines Thai Cathay JAL	8.2 7.9 9.1 14.3 **9.9***	Cebu pacific Air Asia	6.7 6.1 **6.4***	64.6%
Total	11.7*		8.2*		69.76%

Source : Centre for Asia Pacific Aviation, 2002
* Denotes average value.

Although the terminology, 'low cost carrier' is broadly accepted as if it were homogeneous, there are various kinds of LCC models by the types of ownership and operation. Graham (2006) developed a typology of LCC models which classifies five broad types. First, 'Southwest copy-cats' have been remodelled by independent entrepreneurs and are closest to the Southwest model (Doganis, 2001). Second, 'Subsidiaries' refer to LCCs that have been set up as subsidiaries of major carriers targeting the low fare sector. Third, 'Cost cutters' are typically major carriers which are now attempting to cut their operating costs. Fourth, 'Diversified charter carriers' are low cost subsidiaries developed by charter airlines in order to operate low cost scheduled services. Finally, 'State subsidized' are financially supported by Government ownership or subsidy allowing them to offer low fares.

Table 3.
Typology of LCC

Type	Feature	Carrier
Southwest copy-cats	independent company	WestJet, Ryanair, EasyJet
Subsidiaries	subsidiaries of flag carriers	Song, Tiger Air, JIN Air
Cost cutters	major airline attempting to cut operating costs	British Airways, Air France
Diversified charter carriers	subsidiaries of charter airlines	Thomson by Britannia
State subsidized	financially supported by Government	Air British Columbia

Source : Graham Grancis, 2006

In the domestic aviation market in Korea, there are four LCCs providing competitive aviation service. They are JIN Air, Air Busan, Eastar Jet and Jeju Air. Noteworthy is JIN Air. It is so far the first and the only subsidiary of major carrier, KAL in Korea. The others are partially subsidized by local governments.

Table 4.
LCCs in Korean domestic market

LCC	Ownership	Typology	Route & Frequence		Aircraft
JIN Air	Korean Air (100%)	subsidiaries	Gimpo-Jeju Jeju-Busan	24/day 8/day	Boeing 737-800
Air Busan	Busan City Asiana Airlines	partially state subsidized	Busan-Gimpo Busan-Jeju	28/day 10/day	Boeing 737-500
Eastar Jet	Kunsan City ALPA-K*	partially state subsidized	Gimpo-Jeju Junsan-Jeju	12/day 2/day	Boeing 737-700
Jeju Air	Jeju City Aekyung corp.	partially state subsidized	Jeju-Gimpo Jeju-Busan Jeju-Chungju	34/day 8/day 6/day	Boeing 737-800

* Denotes 'Airline Pilots Association of Korea'

1.2. Research Motivation and Objectives

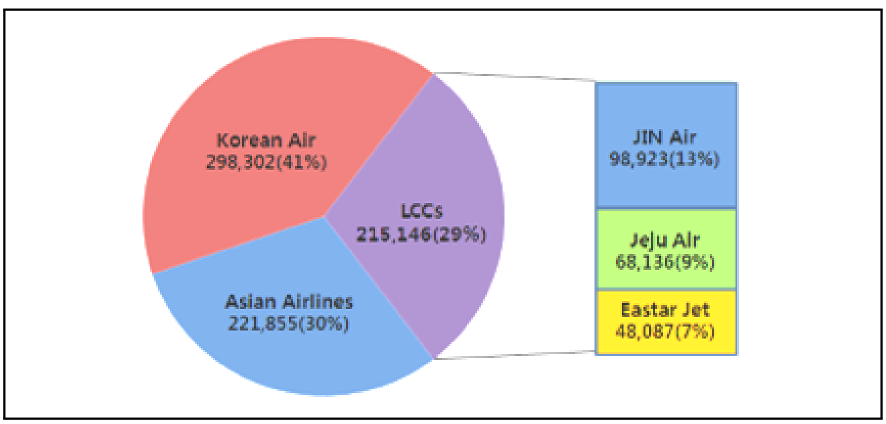
This research mainly focuses on the interdependent relationship of the subsidiary type of LCC and its parent major carrier. When major carriers try to launch a subsidiary, it involves considerable risks such as 'brand dilution' and 'market cannibalization'.

Brand dilution can occur when the subsidiary devaluates the brand of the parent company which is a full service carrier. According to Pilling (2004), major carriers have three options for coping with the problem. (1) To establish a LCC separated from the major carrier's brand. (2) To maintain some linkages between the two. (3) To stretch the airline master brand to encompass a low-fare product. The latter two alternatives provide the assurance of the major carrier's brand.

Market cannibalization occurs when the cheap aviation service of the LCC encroaches on the market share previously occupied by the parent company.

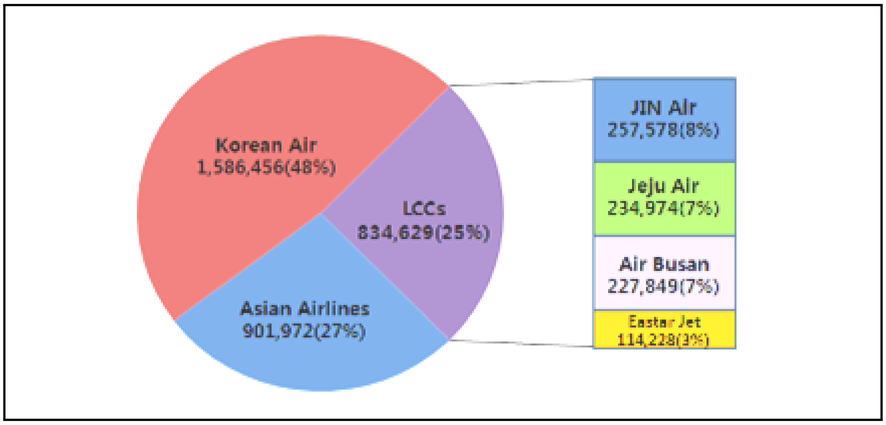
Concerning the two risks above, Korean Air, which is on the top of domestic airlines, seems to have escaped the threatening situations of brand dilution by releasing a new brand of LCC, JIN Air. However, market cannibalization remains a serious problem in that it is possible for Jin Air to cannibalize market shares shared by major carriers such as Korean Air and Asiana Airlines. Furthermore Korean Air's strategy is especially interesting because it allowed JIN Air to operate on the same domestic routes scheduled by Korean Air, from Gimpo to Jeju and from Jeju to Busan.

Recently JIN Air has recorded the highest market share among LCCs in Korea by 13 percent on the Gimpo-Jeju route which is the biggest domestic aviation market, while its parent carrier, Korean Air shows 41 percent on the same route. For such a reason it is reasonable for Korean Air to worry about severe market cannibalization by JIN Air.



Source : Korean Airport Corporation, 2009

Figure 1. Market share on Gimpo-Jeju route by airlines (Passenger, April 2009)



Source : Korean Airport Corporation, 2009

Figure 2. Market share on domestic aviation route by airlines
(Passenger traffic, April~May 2009)

Why do major carriers launch subsidiary types of LCCs? Why do major carriers and their LCCs operate on the same routes? Against this backdrop, this research aims to analyze three topics as follows. First, this paper aims to investigate the effects of LCCs on major carriers' output and total market output. Second, this study will analyze how the joint profit of major carriers and LCCs will change. The final purpose is to examine if the two carriers policy on a certain route can be a dominant strategy.

2. Review of Existing Literature

As LCCs have succeeded in local aviation markets, the LCC model has been studied extensively for the past two decades. The history of the development of LCCs including evolution by era and characteristics by type, have mainly been dealt with Previous studies, however, have paid relatively little attention to analyzing the effects of LCCs' entries into the existing aviation market with the game-theory approach.

2.1. Development of Low Cost Carrier Model

In fact, the terminology, 'low cost carrier' is not enough to cover all types of carriers with low costs. LCCs have developed a variety of modifications in order to gain and maintain their competitiveness and cost advantages over major carriers.

Graham Francis (2006) developed a typology of LCCs and conceptually categorized five broad types of LCCs; Southwest copy-cats, Subsidiaries, Cost cutters, Diversified charter carriers and State subsidized competing on price. The main criterion in this category is the type of ownership. Among the five types, the 'Southwest copy-cat'is the only one which is financially independent and competes with major carriers in local aviation markets.

In contrast, subsidiaries absolutely depend on major carriers. This type of LCC has a great potential for growth owing to sufficient capital and financial support by major carriers. Brian and Timothy (2006) examined the evolution of subsidiaries through time. The initial attempts to establish subsidiaries in the USA originated to fend off competition from Southwest Airlines. Continental Lite became the first US subsidiary by Continental Airlines. On the east coast, Delta Airlines and later US Airways responded to Southwest's entry by creating, respectively Delta Express and MetroJet. However, whenever the subsidiaries competed with Southwest, the advantage was always in favor of the latter (Lawton, 2002). The subsidiaries could not match Southwest's costs and they were also criticized for the lack of distinction between the different brands offered by the airlines and their parent carriers (Beirne, 2004).

According to the Centre for Asia Pacific Aviation Studies (2006), there are five key features attributable to the growth of LCCs, namely, demographic progress, aviation market opportunities, high cost hub airports, and liberalization. To these, Whyte and Prideaux (2008) added two factors. They are the growth of mass tourism in developing nations and technology (such as Internet) allowing costs to be reduced.

2.2. Effects of Low Cost Carriers Entry

In addition to qualitative studies such as the development of the LCC Model, quantitative approaches which analyze the effects of an LCC's entry are also critical. In a recent years, LCCs have been providing their services on long-haul routes as well as on short-haul ones. This suggests that LCCs have established themselves as rivals to major carriers. As a good example, JIN Air, subsidized by KAL, entered the Korean domestic aviation market in July 2008 and has competed with major carriers on the same market including the Gimpo-Jeju and Jeju-Busan routes. Therefore, this is the time to pay more attention to the effects of LCC entry with a quantitative analysis. Curiously, despite the rise of importance as an academic discipline, few have attempted to address the issue through this approach.

Effects of LCC entry have been convincingly demonstrated in two surveys conducted by Windle. Windle (1995) tries to analyze how the effects of low cost carriers' entries on routes is different from the entries of other carriers. With a time series analysis based on data concerning U.S. domestic passenger traffic, this study found that the entries of LCCs, such as Southwest resulted in a greater price reduction and increase in traffic, unlike the entries of major carriers. Consequently, it provided political implications, suggesting that public policy should encourage the expansion of low cost carriers.

Another study on the effects of LCC entry was conducted by Dresner (1999). Dresner (1999) extends the analysis of Windle by examining the impact of LCCs' entries into major carriers' markets in terms of price. Especially interesting findings from the research were that major carriers lowered their fares on competitive routes in response to competition with LCCs.

These two studies, however, have attracted little attention as objects of critical observation because they only focused on the superficial changes in market prices. They have failed to grasp the motivations of LCCs in view of firms' profits when they try to enter major carriers' markets.

2.3. Airline Alliance Issues

It has been a natural phenomenon that a few giant airlines have occupied most of the market share in long-haul and short-haul markets. Because the airline industry is basically exposed to the oligopoly market as other network industries are, firms in the market have to make use of strategies in response to their rival firms to take up dominant state and to maximize their own profits. This is the reason why a number of studies adopt the 'game theory' as a main methodology in analyzing the aviation market. So far, however, there has been little research investigating the effects of LCC entry into major carrier markets with the game theory. For the most part, it was airline alliance issues that analyzed the aviation market with game theory.

In the early stages, Park (1997) examined the effects on firms' output and profits, air-fare, and economic welfare of two types of airline alliances: complementary and parallel alliances. The complementary alliance is likely to increase in total output and reduction in air-fare. On the other hand, a parallel alliance's effect depends on route.

Park et al. (1998) analyzed the effects of airline alliances on partner airlines' outputs by comparing traffic changes on alliance routes with those on non-alliance routes. It was found that most of the partners had greater traffic increases on their alliance routes than those on their non-alliance routes using panel data from North Atlantic alliance routes.

Oum (2001) summarized the main research results concerning global airline alliances and investigated the potential roles of Air Canada and other Canadian air carriers. The paper discussed the effects of alliances on productivity, pricing and profitability of partner carriers. Following a complementary alliance, the partners produced greater output while the equilibrium output of the non-aligned carriers decreased.

In another paper examining complementary and parallel alliances by Park (2001), a complementary alliance was found to likely increase total output whereas a parallel alliance was likely to decrease it. The paper considered segment-based demand specifications, 'full price'.

Zhang, A. et al. (2004) developed an oligopoly model to investigate the effect of an air cargo alliance on competition in passenger markets. The paper proved that such an alliance would likely increase the partner's own output, while simultaneously decreasing its rival's output in air cargo and the passenger market. Furthermore, it found that the objective of the cargo alliance was to enlarge their joint profit and that a cargo alliance reduced the profit of non-aligned rival firms.

Zhang, A. (2005) examined competition models for vertical, horizontal, and hybrid alliances. It was found that even if a vertical alliance created a negative direct effect on profit, it might be pursued because it is a dominant strategy. On the other hand, a horizontal alliance reduced competition not only in the market where prior competition between the partners took place, but also in other markets.

Zhang, A. et al. (2006) investigated a model where each alliance member maximized its own profit and some share of its partner's profit. According to the paper, even though rivalry between different alliances could sometimes lead to a Prisoners' Dilemma for firms, it tended to improve economic welfare. On the other hand, an alliance that arises due to the threat of entry may reduce welfare.

Zhang et al. (2007) examined the effects of multimodal integration on the rivalry between two transport chains: a forwarder-airline alliance and an integrator under the economies of traffic density. An improvement in multimodal integration by a forwarder-airline alliance would increase the alliance's output, while reducing the integrator's output. It would further increase the alliance's profit, provided the intermodal improvement is not too costly, while reducing the integrator's profit.

3. The Model

3.1. Domestic Aviation Market

We begin by constructing a pre-entry situation where no LCCs are yet involved and two major carriers are occupying the domestic aviation market. As depicted in Fig. 3, a simple air transport network is considered, consisting of three airports (or nodes); G, J, B which means Gimpo, Jeju and Busan airport respectively. The network consists of three routes (or links); G-J, J-B, B-G. Both airline 1 (KAL) and 2 (Asiana Airlines) were serving three main routes, providing homogeneous services.

Figure 4. Market situation before LCC's entry

In that situation, there was a change when two LCCs jumped into the domestic aviation market. JIN Air and Air Busan began to provide local aviation services in Jul. 2008 and Oct. 2008. As mentioned above, JIN Air is a subsidiary of KAL and Air Busan is not a subsidiary but partially owned by Asiana Airlines. Consequently, LCCs began to compete with major carriers in the domestic aviation market.

Figure 5. Market situation after LCC's entry

Even though the two major carriers seemed to adopt the same strategy introducing each LCC, there was a big difference between the two strategies. KAL allowed JIN Air to serve on overlapped routes G-J and J-B by adding JIN Air. On the other hand, Asiana Airlines decided to cease operation on J-B and B-G routes by replacing its own carrier with its co-shared LCC, Air Busan. As a result, the market situation was changed from a duopoly market to an oligopoly one served by two or three carriers by routes.

Table 5.
Market Situation After LCC's Entry.

Market	Route	Carriers		
1	G-J	M	vs.	M
		L		
2	J-B	M	vs.	
		L		L
3	B-G	M	vs.	L

'M' and 'L' denote major carrier and LCC respectively.

From Table 5, we can see that three different games are going on in the domestic aviation market. To be specific, the group of KAL and JIN Air make use of the two carrier policy on route G-J and J-B and the one carrier policy on route B-G, whereas Asiana Airlines and Air Busan adopt only the one carrier strategy on every route.

3.2. Structure of Games

3.2.1. Gimpo-Jeju Market

The Gimpo-Jeju market is the largest one and it took up 38.09 percent of passenger traffic in Korea in 2007. It deserves to have been an arena for competition between major carriers.

In our model, the structure of the G-J game is as follows. First, there are three players; a group consisting of 1 and 3 and another player, $2; I = 1, 2, 3$. Second, there are two options that players can adopt; two carrier or one carrier strategy; $S_i = S_1 \times S_2$. Finally, each player's payoff is $\pi_1 + \pi_3$ for player $1, \pi_3$ for player 3 and π_2 for player 2. Of special interest is a difference in payoff for player 1 and player 3. Since JIN Air is fully owned by KAL, it is reasonable for KAL to try to maximize joint profits of KAL and JIN Air, $\pi_1 + \pi_3$. In contrast to KAL's situation, JIN Air pursues to maximize its own profit, π_3 as a new follower.

Let us step inside for a better look. Three players are facing the 'two-stage Stackelberg-Cournot competition'. The timing of the game is as follows: In the first stage, airline 1 and 2 choose each quantity $q_1 \geq 0,\ q_2 \geq 0$, while anticipating their own quantity choice will be met with the reaction $R_3(q_1, q_2)$.

In the second stage, firm 3 observes q_1, q_2 and then chooses a quantity $q_3 \geq 0$.

3.2.2. Jeju-Busan Market

The Jeju-Busan market does not differ much from the Gimpo-Jeju market. The only difference is that the rival carrier of firm 1 and 3 is firm 4 which is a LCC, Air Busan, not a major carrier. That is, one major carrier and two LCCs are facing quantity-competition.

The J-B market has three players, just like the G-J market a group consisting of 1 and 3 and another player, 4; $I = 1, 3, 4$ and two strategic options; two carrier or one carrier policy; $S_i = S_1 \times S_2$. Each player's payoff is $\pi_1 + \pi_3$ for player 1, π_3 for player 3 and π_4 for player 4.

During two-stage Stackelberg-Cournot competition, airline 1 chooses a quantity $q_1 \geq 0$ at the first stage, while anticipating its quantity choice q_1 will be met with the reaction $R_3(q_1, q_4)$ and $R_4(q_1, q_4)$. Airline 3 and 4 observe q_1 and then choose a quantity $q_3 \geq 0$, $q_4 \geq 0$.

3.2.3. Busan-Gimpo Market

The Busan-Gimpo market is moderate-sized, accounting for 15.56 percent of passenger traffic in Korea in 2007. Unlike the two markets mentioned above, the B-G market has a relatively simple structure. It comes from the situation where two players are competing at only one stage.

In the B-G market, player 1 and 4 are facing on quantity competition; $I = 1, 4$ and having only one carrier policy; $S_i = S_1$. Each player's payoff is π_1 for player 1 and π1 for player 4. The notable thing is that the payoff of player 1 is π_1, not $\pi_1 + \pi_3$ suggesting each player is pursuing respective profit maximization. That is because player 3, JIN Air is not involved in the market.

During one-shot Cournot competition, airline 1 and 4 choose a quantity $q_1 \geq 0$, $q_4 \geq 0$. simultaneously, while anticipating their quantity choice q_1, q_4 will be met with the reaction $R_4(q_1)$, $R_1(q_4)$ respectively.

A summary of the essential points of the three different games outlined above is as follows.

Table 6.
Summary of Three Different Games in Domestic Aviation Market.

Route	Players	Strategy		Type of Game
G-J	KAL(1), JIN Air(3) Asiana Airlines(2)	2 carriers 1 carrier	M, L M	Two-stage Stackelberg Cournot competition
J-B	KAL(1), JIN Air(3) Air Busan(4)	2 carriers 1 carrier	M, L L	Two-stage Stackelberg Cournot competition
B-G	KAL(1) Air Busan(4)	1 carrier 1 carrier	M M	One-shot Cournot competition

'M' and 'L' denote major carrier and LCC respectively.

3.3. Assumptions

In order to define our model clearly and to simplify the analysis, we set up four assumptions as follows.

i) Markets are limited to local aviation routes where market externality is excluded. As a matter of fact, we can consider various kinds of factors such as changes of oil prices, worldwide or local business cycles and so on, which affect firms' operating costs and prices. However, we excluded these exterior factors in our model.

ii) All players pursue to gain maximized profits. According to the firm's status and intention in the market, there can be many different goals such as maximizing market share, output and profit. Certain firms at the initial stage tend to have their market shares maximized, if market share is the firm's payoff. In our model, however, payoff is defined as the firm's respective or joint profit.

iii) The operating cost of an LCC is less than that of a major carrier. As discussed earlier, unit cost of LCCs were about 30 percent lower than that of major carriers. Therefore, it can be a natural setting that the marginal cost of LCCs $\alpha c(0 < \alpha < 1)$ is different from that of major carriers; c.

iv) Each market is either single or split into two different ones. We define a single market when a new LCC competes with major carriers in the same market. Contrarily, if the market is divided into two; the major carrier market and LCC market, we define it as a split market. Even though it is not simple to confirm which kind of market setting is appropriate for our purpose, we can produce meaningful results by comparing quantities and profits in two different markets.

3.4. Demand Curve

Since we assume two different markets after the LCC's entry; single or split, the inverse demand function should be differentiated by market formation. In the single market, the inverse demand function is written as:

$P = P(q_i, q_j, q_k) = 1 - q_i - q_j - aq_k$

where subscript i, j, k stand for each firm; i and j are major carriers and k is the LCC. Furthermore, we set to have a range from 0 to 1. It is for differentiating the effect of quantity on price between the major carrier and LCC. Owing to the value of, the LCC has smaller effect on price than major carriers.

At the split market, the inverse demand functions are assumed to be unidentical.

$P = P(q_i, q_j) = \beta - q_i - q_j$: Major carrier market

$P = P(q_i, q_j) = (1 - \beta) - q_i - q_j$: LCC market

where subscript i and j stand for each firm and β denotes the size of the major carrier market; ranging from 0 to 1 . Naturally, $(1 - \beta)$ stands for the size of the LCC market.

3.5. Cost and Profit function

3.5.1. Cost Function

The firm's cost function may be expressed as: $C_i(q_i) = cq_i$

which indicates that marginal cost is constant; $c(0 < c < 1)$ and that only carrying-costs are considered, excluding the firm's fixed costs. Furthermore, in order to reflect the cost-gap between the LCC and major carrier, we set the LCC's marginal cost as α c. denotes the ratio of the LCC's marginal cost to the major carrier's marginal cost;

$$\alpha = \frac{MC_{LCC}}{MC_{Major\ Carrier}}; (0 < \alpha < 1)$$

Therefore, the LCC's cost function can be expressed as: $C_i(q_i) = \alpha c q_i$

3.5.2. Profit Function

Given the assumptions, using total revenue and total cost, each airline's profit function can be written as:

$KAL(\pi_{1+3})$
$=\pi_1(Q)+\pi_3(Q)$
$=p(Q)q_1-cq_1+p(Q)q_3-\alpha cq_3$
Asiana Airlines(π_2)= $\pi_2(Q)=q(Q)q_2-cq_2$
Air Busan(π_4)= $\pi_4(Q)=q(Q)q_4-\alpha cq_4$

where subscript 1,2,3 and 4 stand for each airline.

The airline, KAL's profit is worth paying attention to, in that it is expressed as sum of π_1 and π_3. However it does not mean simple aggregation of the respectively maximized profit of two firms; obtained from the first-order condition, $\frac{\alpha\pi_1}{\alpha q_1}=0$, $\frac{\alpha\pi_3}{\alpha\pi_3}=0$, it is a jointly maximized profit; solved from. $\frac{\alpha(\pi_1+\pi_3)}{\alpha q_1}=0$

The primary goal of this thesis is to compare airline's output, profit and market output before and after the LCC's entry, in order to examine the effects of the LCC.

4. Results and Implications

4.1. Cournot-Stackelberg Equilibrium by Market

In this section, we draw the results of the Cournot equilibrium from our models, the two-stage Stackelberg games. In the Cournot model, the strategies available to each airline are the different quantities, the number of seats that it might produce. The Cournot-Nash equilibrium can be valid when each player's predicted strategy must be that player's best response to the predicted strategies of the other players.

Additionally, Cournot-Stackelberg equilibrium can be established when the leaders, KAL or Asiana Airlines move first and followers, JIN Air or Air Busan, move second. In this structure, an equilibrium can be deduced by using the backwards induction in which we solve the second stage in advance, given the outcome from the first stage.

We first classify the domestic aviation market as two categories on JIN Air's entry basis; prior and post to JIN Air's entry, and then divide each market by a single and split market. The results are composed of the airline's output, profit and total output by market;

Gimpo-Jeju, Jeju-Busan, and Busan-Gimpo. In order to confirm the detailed process of calculations, it will be helpful to refer to Appendices A and B. The numerical results are as follows:

Table 7.

Outputs and Profits on Cournot & Two-Stage Stackelberg Equilibrium

• Route: Gimpo-Jeju • Player: KAL(1), Asiana Airlines(2), JIN Air(3)

Market	Player	Output(q*)	
Prior to JIN Air's entry	1	$\frac{1-c}{3}$	$\frac{2(1-c)}{3}$
Prior to JIN Air's entry	2	c	
Single Market	1	$\frac{(2a+2)(1-c)-(a+3)(1-\alpha c)}{3a-1}$	$\frac{(8a-4)(1-c)-(4a-3)(1-ac)}{2(3a-1)}$
Single Market	2	$\frac{(2a-2)(1-c)-(a-3)(1-\alpha c)}{3a-1}$	
Single Market	3	$\frac{-4(1-c)+5(1-\alpha c)}{2(3a-1)}$	
Split Market	1	$\frac{\beta-c}{3}$	$\frac{2(\beta-c)}{3}+\frac{(1-\beta)-\alpha c}{2}$
Split Market	2	$\frac{\beta-c}{3}$	
Split Market	3	$\frac{(1-\beta)-\alpha c}{2}$	
Market	**Player**	**Profit()**	
Prior to JIN Air's entry	1	$(q_1*)^2$	$(q_1*)^2+(q_2*)^2$
Prior to JIN Air's entry	2	$(q_2*)^2$	
Single Market	1	$\frac{1}{2}p1*q2*+a(q3*)^2$	$\frac{1}{2}q1*q2*+\frac{1}{2}(q2*)^2+a(q_3*)^2$
Single Market	2	$\frac{1}{2}(q_2*)^2$	
Single Market	3	$a(q_2*)^2$	
Split Market	1	$(q_1*)^2+(q_3*)^2$	c
Split Market	2	$(q_2*)^2$	
Split Market	3	$(q_3*)^2$	

Table 8.
Outputs and Profits on Cournot & Two-Stage Stackelberg Equilibrium

Market		Player	Output()	
Prior to JIN Air's entry	Single Market	1	$\frac{2(1-c)-(1-\alpha c)}{3}$	$\frac{(2a-1)-(1-c)}{3a}-\frac{(a-2)(1-\alpha c)}{3a}$
Prior to JIN Air's entry	Single Market	4	$\frac{-(1-c)+2(1-\alpha c)}{3a}$	
Prior to JIN Air's entry	Split Market	1	$\frac{\beta-c}{2}$	$\frac{1-c-\alpha c}{2}$
Prior to JIN Air's entry	Split Market	4	$\frac{(1-\beta)-\alpha c}{2}$	
Single Market		1	$\frac{9a(1-c)-(6a+2)(1-\alpha)}{2(3a-1)}$	$\frac{(9a-6)(1-c)}{2(3a-1)}-\frac{(9a-6)(1-c)}{2(3a-1)}$
Single Market		3	$\frac{-3(1-c)-4(1-\alpha c)}{2(3a-1)}$	
Single Market		4	$\frac{-3(1-c)-4(1-\alpha c)}{2(3a-a)}$	
Split Market		1	$\frac{\beta-c}{2}$	$\frac{\beta-c}{2}+\frac{(1-\beta)-\alpha}{3}$
Split Market		3	$\frac{(1-\beta)-\alpha c}{3}$	
Split Market		4	$\frac{(1-\beta)-\alpha c}{3}$	
Market		**Player**	**Profit()**	
Prior to JIN Air's entry	Single Market	1	c	$(q_1*)^2+a(q_4*)^2$
Prior to JIN Air's entry	Single Market	4	$a(q_4*)^2$	
Prior to JIN Air's entry	Split Market	1	$(q_1*)^2$	$(q_1*)^2+(q_4*)^2$
Prior to JIN Air's entry	Split Market	4	$(q_4*)^2$	
Single Market		1	$\frac{1}{2}(q_1*+q_3*+q_4*)q_1*+c$	$\frac{1}{3}(q_1*+q_3*+q_4*)q_1*+a(q_3*)^2+a(q_4*)^2$
Single Market		3	$a(q_3*)^2$	
Single Market		4	$a(q_4*)^2$	
Split Market		1	$(q_1*)^2+(q_3*)^2$	$(q_1*)^2+(q_3*)^2+(q_4*)^2$
Split Market		3	$(q_3*)^2$	
Split Market		4	$(q_4*)^2$	

Table 9.
Outputs and Profits on Cournot Equilibrium
• Route: Busan-Gimpo • Player: KAL(1), Air Busan(4)

Market	Player	Output()		Profit()	
Single Market	1	$\frac{2(1-c)-(1-\alpha c)}{3}$	$\frac{(2a-1)(1-c)}{3a} - \frac{(a-2)(1-ac)}{3a}$	$(q_1*)^2$	$(q_1*)^2 + a(q_4*)^2$
Single Market	4	$\frac{-(1-c)+2(1-\alpha c)}{3}$		$a(q_4*)^2$	
Split Market	1	$\frac{\beta-c}{2}$	$\frac{1-c-\alpha c}{2}$	$(q_1*)^2$	$(q_1*)^2 + (q_4*)^2$
Split Market	4	$\frac{(1-\beta)-\alpha c}{2}$		$(q_4*)^2$	

4.2. Output Analysis

The fundamental purpose of this paper is to analyze effect of JIN Air's entry on the existing routes in terms of output and profit, especially of KAL. As a parent company of JIN Air, KAL pursues jointly-maximized profits of its own and its subsidiary. Therefore, it can be a meaningful study to investigate whether KAL would either increase or decrease its output when JIN Air enters routes previously occupied by KAL and Asiana Airlines. The output analysis is composed of four propositions as follows.

Proposition 1-1.

JIN Air's entry reduces respective output of KAL $(= q_1)$ as well as joint-output of KAL and JIN Air $Air = (q_1 + q_3)$ in $G-J$, $J-B$ single market.

First of all, we compare and in order to know if the respective output of KAL would be increased or decreased, then compare and in order to confirm changes of KAL and JIN Air's joint-output. Subscript denotes 'before JIN Air's entry and A denotes 'after that'.

From the results of the Cournot & Two-Stage Stackelberg Equilibrium on route G-J, and produce;

(Route G-J)

$$q_{1B}=\frac{1-c}{3}$$

$$q_{1A}=\frac{(2a+2)(1-c)-(a+3)(1-\alpha c)}{3a-1}$$

$$q_{1B}-q_{1A}=\frac{2(1-c)+c(3a+9)(1-\alpha)}{3(3a-1)}>0,$$

where the second-order condition is $a>\frac{1}{2}$. In the range satisfying the second-order condition of, KAL chooses to reduce its own output; $q_{1B}>q_{1A}$.

Then, how would this change the joint-output of KAL and JIN Air? From the results of Cournot & Two-Stage Stackelberg Equilibrium on route $G-J$, q_{1B} and $q_{1A}+q_3$ produce;

$$q_{1B}=\frac{1-c}{3}$$

$$q_{1A}=\frac{(2a+2)(1-c)-(a+3)(1-\alpha c)}{3a-1},\quad q_3=\frac{-4(1-c)+5(1-\alpha c)}{2(3a-1)}$$

$$q_{1B}-(q_{1A}+q_3)=\frac{(1-c)+c(6a+8)(1-\alpha)}{6(3a-1)}>0,$$

Where the second-order condition is $a>\frac{1}{2}$. In the range satisfying the second-order condition of a, the joint-output of KAL and JIN Air would be reduced compared to KAL's own output before JIN Air enters; c

In route $J-B$, we can deduce similar results from the same calculating process;

(Route J-B)

$$q_{1B}=\frac{2(1-c)-(1-\alpha c)}{3}$$

$$q_{1A}=\frac{9a(1-c)-(6a+2)(1-\alpha c)}{2(3a-1)}$$

$$q_{1B}-q_{1A}=\frac{-(3a-4)(1-c)+c(12a+8)(1-\alpha)}{6(3a-1)}>0,$$

where the second-order condition is a>1/3. In the range satisfying the second-order condition of a, KAL chooses to reduce its own output;. $q_{1B} > q_{1A}$

In terms of joint-output of KAL and JIN Air, q_{1B} and $q_{1A} + q_3$ produce;

$$q_{1B} = \frac{2(1-c)-(1-\alpha c)}{3}$$

$$q_{1A} = \frac{9a(1-c)-(6a+2)(1-\alpha c)}{2(3a-1)}, \quad q_3 = \frac{-3(1-c)+4(1-\alpha c)}{2(3a-1)}$$

$$q_{1B} - (q_{1A} + q_3) = \frac{-(1-c)+4c(q-\alpha)}{6} > 0,$$

$$\alpha < \frac{1}{4c} + \frac{5}{4}$$

where. In the range satisfying specific conditions; α and , c, the joint-output of KAL and JIN Air would be reduced compared to KAL's own output before JIN Air enters; .

$q_{1B} > q_{1A} + q_3$

Although JIN Air eats away at KAL's previous output, KAL can offset output-losses by gaining its subsidiary's output, which did not exist previously. This can be a partial reason for KAL to launch JIN Air on the same route.

Proposition 1-2.

JIN Air's entry increases output of rival firms, Asiana$(= q_2)$ in G-J and Air Busan $(= q_4)$ in J-B single market.

In contrary to the position of KAL, Asiana Airlines and Air Busan certainly consider JIN Air-entry as a new rival. Let us check their response by comparing their outputs before and after JIN Air's entry.

From the results of the Cournot & Two-Stage Stackelberg Equilibrium on route G-J, and produce;

(Route G-J)

$$q_{2B} = \frac{1-c}{3}$$

$$q_{2A} = \frac{(2a-2)(1-c)-(a-2)(1-\alpha c)}{3a-1},$$

$$q_{2B} - q_{2A} = \frac{-(1-c)+c(3a-6)(1-\alpha)}{3(3a-1)} < 0,$$

where the second-order condition is $a > \frac{1}{2}$. In the range satisfying the second-order condition of a , Asiana Airlines increases its own output; $q_{2B} < q_{2A}$.

Similarily, Air Busan, which is another LCC in route J-B, increases output. From the results of the Cournot & Two-Stage Stackelberg Equilibrium on route J-B, q_{4B} and q_{4A} produce;

$$q_{4B} = \frac{-(1-c)+2(1-\alpha c)}{3a}$$

$$q_{4A} = \frac{-3(1-c)+4(1-\alpha c)}{2(3a-1)},$$

$$q_{4B} - q_{4A} = \frac{(3a-2)(1-c)-4c(1-\alpha)}{6(3a-1)} < 0,$$

(Route J-B)

where the second-order condition of $a > \frac{1}{3}$ and the specific range of $\frac{1}{3} < a < \frac{2}{3}$. In the range satisfying these conditions, Air Busan increases its own output; $q_{4B} < q_{4A}$

Proposition 1-3.

JIN Air's Entry Increases Total Output in G-J and J-B Single Market.

Interestingly, the entry of JIN Air decreases its parents company, KAL's output and increase its rival companies' output in certain conditions of a. Then, how does the total output in those markets? In order to investigate this point, we compare MO_B and MO_A on route G-J and J-B where MO_B denotes 'market output'.

From the results of the Cournot & Two-Stage Stackelberg Equilibrium on route G-J, and produce;

(Route G-J)

$$MO_B = \frac{2(1-c)}{3}$$

$$MO_A = \frac{(8a-4)(1-c)-(4a-3)(1-\alpha c)}{2(3a-1)}$$

$$MO_B - MO_A = \frac{-(1-c)+c(12a-9)(1-\alpha)}{6(3a-1)} < 0,$$

where the second-order condition of $a > \frac{1}{2}$ and the specific range of a $\frac{1}{2} < a < \frac{3}{4}$. In the range satisfying these conditions, total output in the G-J market would increase after JIN Air enters;

$MO_B < MO_A$.

(Route J-B)

$$MO_B = \frac{(2a-1)(1-c)-(a-2)(1-\alpha c)}{3a}$$

$$MO_A = \frac{(9a-6)(1-c)-(6a-6)(1-\alpha c)}{2(3a-1)}$$

$$MO_B - MO_A = \frac{-(3a^2-4a+2)(1-c)+c(12a^2-4a-a)(1-\alpha)}{6a(3a-1)} < 0,$$

where the second-order condition of $a > \frac{1}{3}$ and the specific range of a ; $\frac{1}{3} < a < \frac{3}{4}$. In the range satisfying these conditions, the total output in the J-B market would increase after JIN Air enters; $MO_B < MO_A$

The results of the total output comparison indicate that the total increased outputs of JIN Air, Asiana Airlines and Air Busan surpass the reduced output of KAL; $|\triangle q_1| < |q_3 + \triangle q_2 + \triangle q_4|$ where $\triangle q_i$ denotes $q_{iB} - q_{iA}$.

Proposition 1-4.

KAL produce less output when it pursues joint-profit maximization rather than respective-profit maximization after JIN Air entered, in G-J, J-B market.

There are two factors that make KAL produce less output. The one has already been mentioned, it is JIN Air's entry as an external factor. The other is KAL's intention toward profit, joint-profit maximization$(\partial(\pi_1 + \pi_3)/\partial q_1 = 0)$ rather than respective one $(\frac{\partial \pi_1}{\partial \pi_1} = 0,\ \frac{\partial \pi_3}{\partial \pi_3} = 0)$. We can verify it by comparing with where subscript and denote respective and joint each.

From the results of the Cournot & Two-Stage Stackelberg Equilibrium on route G-J, $q_{1A(Rsp)}$. and $q_{1A(Jnt)}$. produce;

(Route G-J)

$$q_{1A(Rsp)} = \frac{2(1-c)-(1-\alpha c)}{3}$$

$$q_{1A(Jnt)} = \frac{(2a+2)(1-c)-(a+3)(1\alpha c)}{3a-1}$$

$$q_{1A(Rsp)} - q_{1A(Jnt)} = \frac{2(1-c)+10c(1-\alpha)}{3(3a-1)} > 0$$

where the second-order condition is $a > \frac{1}{2}$

(Route J-B)

$$q_{1A(Rsp)} = \frac{2(1-c)-2(1-\alpha c)}{3}$$

$$q_{1A(Jnt)} = \frac{9a(1-c)-(6a+2)(1-\alpha c)}{2(3a-1)}$$

$$q_{1A(Rsp)} - q_{1A(Jnt)} = \frac{-3(1-c)+4(1-\alpha c)}{6(3a-1)} > 0$$

where the second-order condition is $a > \frac{1}{3}$

In the range satisfying the second-order condition of, KAL's output is smaller on the intention of joint-profit maximization rather than respective one; $q_{1A(Rsp)} > q_{1A(Jnt)}$.

4.3. Profit Analysis

Through previous output analysis, we verified the effects of JIN Air's entry on its parent company and rival firms. Unfortunately, there cannot be answers to the initial motivations of this study; Why do major carriers launch subsidiary types of LCCs? Why do major carriers and their LCCs operate on the same routes? Since we assumed that all players pursued to gain the maximized profits-not quantities, we must carry out profit analysis in order to answer the original questions. The profit analysis is composed of three propositions as follows.

Proposition 2-1.

As JIN Air's output increases, joint profit of KAL and JIN Air increases, but rival firms' profits decrease in G-J and J-B single markets.

If JIN Air's entry is conducive to the joint profits of KAL and JIN Air, even though it decrease KAL's output, it may be a reasonable explanation about KAL's two carrier policy. We can verify it by differentiating each firm's profit function by JIN Air's output$(= q_3)$; $\frac{\partial(\pi_{1A}+\pi_3)}{\partial(q_3)}$, $C\frac{\partial \pi_{4A}}{\partial q_3}$.

From the firms' profit functions, given in section 4.5.2, each differential calculus produces

(Route G-J)

$$\frac{\partial(\pi_{1A}+\pi_{3)}}{\partial q_3} = \frac{\partial p}{\partial q_3}q_1,\ \frac{\partial p}{\partial 1_3}q_3 + p - \alpha c$$

$$= aq_1 - aq_3 + (1 - \alpha c - q_1 - q_2 - aq_3)$$

$$= \frac{-(a^2-a)(1-c)+c(a^2+3a)(1-\alpha)}{3a-1} > 0$$

where the second-order condition is $a > \frac{1}{2}$

$$c = \frac{\partial p}{\partial q_3}q_2 = \frac{\partial(1-c-q_1-q_2-aq_3)}{\partial q_3}q_2 =- aq_2 < 0$$

(Route J-B)

$$c = \frac{\partial p}{\partial q_3}q_1,\ \frac{\partial p}{\partial q_3}q_3 + p - \alpha c$$

$$= aq_1 - aq_3 + (1 - \alpha c - q_1 - aq_3 - aq_4)$$

$$= \frac{-(3a^2-2a)(1-c)+c(6a^2+2a)(1-\alpha)}{2(3a-1)} > 0$$

where the second-order condition is $a > \frac{1}{3}$ and the specific range of a $\frac{1}{3} < a < \frac{2}{3}$,

$$\frac{\partial \pi_{4A}}{\partial q_3} = \frac{\partial p}{\partial q_3}q_4 = \frac{\partial(1-\alpha c-q_1-aq_3-aq_4)}{\partial q_3}q_4 =- aq_4 < 0$$

Of course, as JIN Air's output increases, KAL's own profit would decrease like other firms; $\frac{\partial \pi_{1A}}{\partial q_3} = -aq_1 < 0$, but if we consider KAL's original purpose of launching JIN Air, its two carrier policy can be estimated to be profitable;

$$\frac{\partial(\pi_{1A}+\pi_3)}{q_3} > 0 \approx \left|\frac{\partial \pi_{1A}}{\partial q_3}\right| < \left|\frac{\partial \pi_3}{\partial q_3}\right|$$

Proposition 2-2.

From the joint-profit aspect, increasing KAL's output than JIN Air's is more profitable in the G-J market, on the other hand, increasing JIN Air's output a level higher than KAL's is more profitable in the J-B market.

On the basis of proposition 2.1, the question of which firm's output is more beneficial to the joint-profit of KAL and JIN Air, is raised? In order to find an answer to this question, we need to compare each marginal profit differentiated by q_1 and q_3. $\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3}, \frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3}$

From the firms' profit functions, given in section 4.5.2, each differential calculus produces

(Route G-J)

$$\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3} = \frac{-(a^2-a)(1-c)+c(a^2+3a)(1-\alpha)}{3a-1} \ (>0)$$

$$\frac{\partial(\pi_{2A}+\pi_3)}{\partial q_1} = \frac{(1-a)(1-c)+c(a^2+3a)(1-\alpha)}{2(3a-1)} \ (>0)$$

$$\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3} - \frac{\partial(\pi_{1A}+\pi_3)}{\partial q_1} = \frac{(-4a^2-2a+2)(1-c)+(2a^2+5a-3)(1-\alpha c)}{2(3a-1)} < 0,$$

where the second-order condition is $a < \frac{1}{2}$. Since KAL and JIN Air's rival firm is a major carrier, increasing KAL's output seems to be more beneficial in the G-J market;

$$\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3} < \frac{\partial(\pi_{1A}+\pi_3)}{\partial q_1}$$

(Route J-B)

$$\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3}=\frac{-(3a^2-2a)(1-c)+c(6a^2+2a)(1-\alpha)}{2(3a-1)}(>0)$$

$$\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3}=\frac{(-2a+1)(1-c)+4ac(1-\alpha)}{2(3a-1)}(>0,\text{if }\frac{1}{3}<a<\frac{1}{2})$$

$$\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3}-\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3}=\frac{-(3a^2-4a-1)(1-c)+c(6a^2-2a)(1-\alpha)}{2(3a-1)}>0,$$

where the second-order condition is $a>\frac{1}{3}$. In the J-B market, adding JIN Air's output is more profitable, considering their rival firm is a LCC; .

$$\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_3}>\frac{\partial(\pi_{1A}+\pi_3)}{\partial q_1}$$

Proposition 2-3.

As JIN Air produces more, the firms' total profit$(=\pi_{1A}+\pi_{2A}+\pi_3)$ increases in the G-J and J-B single markets.

How do total profits change in those market as JIN Air's output increases? In order to investigate this point, we need to differentiate each total profit(TP) function by JIN Air's output$(=q_3)$; $\frac{\partial TP}{\partial q_3}$ on the G-J and J-B markets.

From the firms' profit functions, given in section 4.5.2, each differential calculus produces

(Route G-J)

$$\frac{\partial TP}{\partial q_3}=\frac{\partial}{\partial q_3}(\pi_{1A}+\pi_{2A}+\pi_3)=\frac{\partial p}{\partial q_3}q_1+\frac{\partial p}{\partial q_3}q_2+\frac{\partial p}{\partial q_3}q_3+p-\alpha c$$

$$=-a(q_1+q_2+q_3)+(1-\alpha c-q_1-q_2-aq_3)$$

$$=\frac{-(2a^2-a)(1-c)+c(2a^2+a)(1-\alpha)}{3a-1}>0$$

where the second-order condition is, $a>\frac{1}{2}$, and the specific range of α and c.

$$\alpha<\frac{(2a-1)}{(2a+1)c}+\frac{4a}{2a+1}$$

(Route J-B)

$$\frac{TP}{\partial q_3} = \frac{\partial}{\partial q_3}(\pi_{1A} + \pi_3 + \pi_{4A}) = \frac{\partial p}{\partial q_e} q_1 + \frac{\partial p}{\partial q_3} q_3 + \frac{\partial p}{\partial q_3} q_4 + 2(p - \alpha c)$$

$$= - a(q_1 + q_2 + q_3) + 2(1 - \alpha c - q_1 - a q_3 - a q_4)$$

$$= \frac{1(3a^2 - 2a)(1-c) + c(6a^2 + 2)(1-\alpha)}{2(3a-1)} > 0$$

where the second-order condition is $a > \frac{1}{3}$, and the specific range of $\alpha; \frac{1}{3} < a < \frac{2}{3}$

4.4. Low Cost Carrier's Cost Analysis

This section investigates the relationship between major carriers and their subsidiaries. There are two factors linking KAL and JIN Air: one is KAL's intention of joint-profit maximization and the other is JIN Air's status as subsidiary of KAL. Nevertheless, KAL and JIN Air seem to get caught on an unresolved conflict on level of LCC cost(=α) by market formation; single and split one. LCC cost analysis is as follows.

Proposition 3.

KAL and JIN Air get caught on an unresolved conflict on level of LCC cost(=α) in G-J, J-B single and split market.

We assume a new function; $d^i = q*_{i(Sg)} - q*_{i(st)}$ where Sg denotes 'single market' St denotes 'split market'. As it is defined, d^i refers to the differences between the two quantities in a differently formed market. When d^i is differentiated by $a, d^i_\alpha = \frac{\partial d^i}{\partial \alpha} = \frac{\partial(q*_{i(Sg)} - q*_{i(St)})}{\partial \alpha}$ would mean the change of the quantities' differences with respect a, i f $d^i_\alpha > 0$,

i firm prefers single market formation as α increases, in contrast, $d^i_\alpha < 0$, I firm prefers split market formation.

From the results of the Cournot & Two-Stage Stackelberg Equilibrium on route G-J and J-B, d^{1+3}_α and d^3_α produce;

(Route G-J)

$$d^{1+3}_\alpha = - \frac{a-2}{2(3a-1)} c > 0, \ d^3_\alpha = - \frac{3a+4}{2(3a-1)} c < 0$$

(Route J-B)

$$d_{\alpha}^{1+3} = -\frac{2(3a-1)}{3(3a-1)}c > 0,\ d_{\alpha}^{3} = -\frac{6a+10}{6(3a-1)}c < 0$$

Table 10.

Market Formation Preferred by Carriers.

		KAL	
		$\alpha\uparrow$	$\alpha\downarrow$
JIN Air	$\alpha\uparrow$	Split / Single	Split / Split
	$\alpha\downarrow$	Single / Single	Single / Split

From the results above, we can deduce that KAL and JIN Air may face structural conflict over α. In a single market, JIN Air is in favor of a low level of α to increase its own quantity, however KAL is the opposite. In a split market, on the other hand, the former prefers a high level of α, while the latter wants to lower α.

Up to now, we have discussed the crucial implications for the results with several propositions. A summary of the essential points is as follows.

Table 11.

Summary of Propositions

Route	**Gimpo-Jeju**	**Jeju-Busan**
Output	$q_{1B} > q_{1A}$	$q_{1B} > q_{1A}$
	$q_{1B} > q_{1A} + q_3$	$q_{1B} > q_{1A} + q_3;\ \alpha < \frac{1}{4c} + \frac{1}{5}$
Profit	$\frac{\partial \pi_{1A} + \pi_3}{\partial q_3} > 0,\ \frac{\partial \pi_{2A}}{\partial q_3} < 0$	$\frac{\partial \pi_{1A} + \pi_3}{\partial q_3} > 0,\ \frac{\partial \pi_{4A}}{\partial q_3} < 0$
	$\left\lvert\frac{\partial \pi_{1A}}{\partial q_3}\right\rvert < \left\lvert\frac{\partial \pi_3}{\partial q_3}\right\rvert$	$\left\lvert\frac{\partial \pi_{1A}}{\partial q_3}\right\rvert < \left\lvert\frac{\partial \pi_3}{\partial q_3}\right\rvert;\ \frac{1}{3} < a < \frac{2}{3}$
	$\frac{\partial TP}{\partial q_3} > 0;\ -\frac{(2a-1)}{(2a+1)c} + \frac{4a}{2a+1}$	$\frac{\partial TP}{\partial q_3} > 0;\ \frac{1}{3} < a < \frac{2}{3}$
LCC cost()	Conflict	Conflict

5. Conclusion

This paper has studied the effects of a LCC's entry into a domestic aviation market which was pre-occupied by two major carriers. Through a simple model describing market situations prior and post to the LCC's entry, we analyzed changes and trends of the airline's output and profit with Cournot and two-stage Stackelberg games. In summary, our discussion of the analysis of our results has developed five points:

- Even though JIN Air's entry reduced KAL's respective output and profit, the more JIN Air produces, the higher joint-profit of KAL and JIN Air is (proposition 1-1, 2-1)
- From the joint-profit aspect, increasing KAL's output more than JIN Air's is more profitable in the G-J market. On the other hand, increasing JIN Air's output more than KAL's is more profitable in the J-B market (proposition 2-2)
- Even though JIN Air's entry increases Asiana's output, the more JIN Air produces, the less Asiana Airlines profits is (proposition 1-2, 2-1)
- Total output in markets as well as total profits of firms will increase under certain conditions (proposition 1-3, 2-3)
- KAL and JIN Air get caught in an unresolved conflict on the level of LCC cost, (proposition 3)

From the results, we can give convincing explanations in regard to KAL's two carrier policy on its G-J and J-B routes. Launching a subsidiary type of LCC may encroach on the parent carrier's market share, but KAL and JIN Air's joint- profit will be improved. This point may be what KAL expects with its two carrier policy.

This paper can lay the foundation for future studies on LCCs since it has analyzed the aviation market where major carriers and LCCs are competing with game theoretic approaches. In future studies, we need to extend the research scope to overseas markets as LCCs begin to schedule long-haul routes.

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