A STUDY OF THE EFFECTS OF KOREAN AIRLINE DEREGULATION:

The Impact of Low Cost Carriers (LCCs) Entry on Air Travel Demand and Welfare Gains

A Dissertation

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

by

Joo Yeon Sun

August 2012

A STUDY OF THE EFFECTS OF KOREAN AIRLINE DEREGULATION:

The Impact of Low Cost Carriers (LCCs) Entry on Air Travel Demand and Welfare Gains

Joo Yeon Sun, Ph.D.

Cornell University 2012

This dissertation examines the consequences of the Korean Airline Deregulation Act of May 2008. I propose an empirical methodology for analyzing demand and supply in differentiated product markets that measures welfare effects due to the entry of Low Cost Carriers (LCCs) from two perspectives: pre- and post-deregulation. I have built a panel of airline carrier level data for each of the seven domestic non-stop routes from June 2006 to October 2010 to investigate whether the deregulation policy is desirable for increasing the net welfare gains to air passengers, and for promoting competition among airline carriers.

Chapter 1 explains the implementation and effects of the Act change on the Korean airline industry. The Act removed restrictions imposed on both aircraft size and aircraft age for the non-scheduled air service carriers so that all LCCs were able to operate jet aircraft which had more than 100 seats per airplane. Since May 2008, the competition, long dominated by two legacy carriers, Korean Air (KAL) and Asiana Air (AAR), has intensified as emerging LCCs have began offering lower air fares.

Chapter 2 outlines the empirical framework of the nested logit model and applies it to two categories of city pair routes in Korea: five Jeju island routes and two inland routes. *A priori* there are expectations of differences in both types of travelers and in alternatives to air transportation, thus differences in air travel demand sensitivity to price and non-price factors, such as frequent flights and aircraft size. In this chapter, I find evidence of a common sensitivity to price across the Jeju island routes and the inland routes and route-specific response to flight characteristics.

Thus, I propose a joint constrained model in terms of price sensitivity where the parameter for price variable is constrained to be the same across all seven routes, but the flight characteristics should be permitted to have route-specific effects. Frequent flights, larger aircraft, evenly distributed flight schedules on peak-demand hours (lunchtime for some routes), and shorter airtime duration generate a higher utility for air passengers.

Chapter 3 models the supply side and legacy carriers' strategic responses to the emergence of LCCs. The two legacy carriers established their own subsidiary LCCs (dependent LCCs). KAL entered some routes with its subsidiary LCC, JNA, while AAR rebadged to ABL, its subsidiary LCC, replacing their prior service.

Chapter 4 integrates the demand- and supply-side in order to derive average price elasticities for air travel demand, implied marginal costs and Lerner indices for each carrier's flights. Price-cost markups are recovered after the demand parameters are first obtained and then inserted in the pricing equation. The estimated results for a dominant airline carrier on some inland routes are inconsistent with the static profit maximization assumption, having inelastic demand elasticities and negative marginal costs.

Chapter 5 contributes to the literature on the spatial competition of the airline industry. Empirical findings using time-series data from June 2006 to October 2010 in this chapter suggest that the effects of competition on the degree of inter-firm departure times differentiation would have a different impact across the Jeju island routes and the inland route in the deregulated period.

Chapter 6 evaluates the welfare gains due to the entry of LCCs. I calculate welfare gains from various types of post-deregulation entry behaviors that are driven by the change in market structure. I find a few entries (i.e., none in half the markets) induced by deregulation. The welfare calculations imply that consumer welfare results are mixed and total welfare results have little evidence to support welfare improvement.

I find the introduction of fuel surcharge to be the major obstacles hindering benefits from the Act change for aggregate consumers and industry-wide producers at times of unusually high fuel surcharges. Finally, I summarize and discuss some problems with extensions of this approach.

BIOGRAPHICAL SKETCH

Joo Yeon Sun was born in Seoul, South Korea. She earned her B.A. in Economics from Yonsei University in 2007. From September 2005 to June 2006, she studied economics as undergraduate exchange student at University of Washington, Seattle. She came to Cornell University to pursue her doctoral studies in the fall of 2007. After finishing all requirements for Ph.D. candidacy, Joo Yeon Sun earned her M.A. in Economics in August, 2011, and earned her Ph.D. in Economics in August, 2012 at Cornell University.

DEDICATION

I dedicate this dissertation to my parents:
Chan Jae Sun and Bok Hee Cho.

ACKNOWLEDGMENTS

Writing and completing my dissertation was a long and arduous journey. During the process, I have benefited tremendously by many people's advice and guidance.

I would like to express my special thanks to Robert T. Masson, my dissertation supervisor. I would never have been able to finish my dissertation without the guidance of him. Professor Robert T. Masson was extremely careful in the details, and every time I received comments on my draft from him, it was obvious that he had read my draft sentence-by-sentence multiple times. Not only did he teach me how to approach empirical issues in imperfectly competitive markets very carefully, he always provided extremely important criticisms and intuitions which I have overlooked previously. This made me reorganize the entire structure of my dissertation multiple times.

I would like to thank all of my dissertation committee members, Professor Jeffrey T. Prince and Professor George H. Jakubson. All of their encouragements, criticisms, and guidance made my graduate years at Cornell University intellectually fulfilling. If there are any remaining faults or errors that are left in this final draft, I would like to emphasize that the fault is entirely on my part. This dissertation represents, not a final product, but an ongoing research in empirical economics.

I would also like to thank Professor Kap-Young Jeong at Yonsei University and all the people who provided support outside my graduate program at Cornell.

Last but not least, I extend my special thanks to my parents and elder brother for their endless support.

Joo Yeon Sun

Ithaca, New York

August, 2012

Contents

List of Figures

List of Tables

Chapter 1

Institutional Background

1.1 Introduction

Low cost carriers (LCCs) have emerged and revolutionized short-haul flight markets around the world, expanding the choice of air transport to air passengers at lower fares as a global phenomenon at the end of the 20th century and the beginning of the 21st century. Even though the growth of the airline industry slowed down worldwide over the past few years, the largest LCCs, such as Southwest in the United States, have continued to grow rapidly while new smaller LCCs have collapsed. These have different product and market strategies than the traditional full service legacy carriers. Established legacy carriers, on the other hand, have responded to entry of LCC competitors by diversifying their strategies to compete for the short-haul flights market as well.

As aviation industry dynamics have changed, with deregulation around the globe, the emergence of LCCs has been linked with greater market competition. For example, before 2004, the Korean domestic airline markets were characterized by duopolies: two legacy carriers, Korean Air (KAL) and Asiana Air (AAR) were the only carriers in each domestic city pair market. Since the May 2008 Deregulation Act, the Korean airline industry has undergone significant changes. It is interesting to examine the effects of this deregulation policy on the domestic Korean city pair markets. The competition in some, but not all, of the markets long dominated by KAL and AAR has increased since the deregulation. New LCCs entered a few of these markets at ticket prices of about 70 or 80 percent of the prices being charged by the legacy carriers. Given that a hub-and-spoke system is not the optimal air transport network strategy for Korean domestic short haul routes, the two incumbents have developed new business strategies. The legacy carriers, KAL and AAR, rebadged and entered a few of their own markets with LCC operations either replacing their prior service or competing with it for some city pair routes.

Previously, many empirical papers assessed the effects of the U.S. Airline Deregulation Act of 1978 on travelers and carriers while there have been no such studies focused on the effects of deregulation of the Korean airline industry. Empirical studies of the U.S. deregulation have found hub-and-spoke effects to be important. With allowing carriers more freedom in pricing and in entry and exit since 1978, all fare and entry regulations were eliminated in January 1983. Morrison and Winston [1986] analyzed the welfare effects on air passengers and found the largest source of the welfare gains from deregulation occurred through increases in departure frequencies. Their results suggested that changes in the route structures contributed greatly to the success of the deregulation of 1978 because development of hub-and-spoke route structures increased departure frequencies.

Unlike perfectly competitive markets in which firms take prices as a given, the air travel industry is characterized by differentiated products. With differentiated products, competition has both price and non-price dimensions. Airline carriers choose not only prices, but also flight frequency and flight departure times. One would expect that an introduction of a new entrant would lead to decrease in the prices of other competing airlines. In response to the entry of LCCs, incumbents may significantly reduce fares. On the other hand, incumbents might decrease airline capacities following entry of LCCs. Besides, theoretical models of spatial product differentiation suggest two possible polar cases regarding location competition outcomes: Minimal differentiation in order to steal customers from rivals, and maximal differentiation in order to soften price competition with competitors.

One of the studies in the airline industry literature related to departure flights scheduling competition is Borenstein and Netz [1999]. Spatial competition theory has been applied to airline studies such that airlines compete on departure times where the departure times of flights on a route can be interpreted as locations on a 24-hour clock. They empirically tested the relationship between the level of competition and spatial product differentiation using cross-sectional U.S airline 1975 and 1986 data, respectively for a given number of flights on a route. According to their findings, airlines scheduled their flights more closely to rivals' flights as competition increased for both periods and an even stronger tendency was observed when fares were not regulated (1986) than when fares were regulated (1975). Yetiskul and Kanafani [2010] also tested location theory using cross-sectional U.S. airline 2005 data. They found that for a given number of flights on a route, intense competition leads to less departure time differentiation as expected in Hotelling's model. This tendency is lower in the presence of low cost carriers on a route. In a location of gasoline stations study, however, Netz and Taylor [2002] found the opposite effect, that firms located their stations farther to reduce price competition as competition increased.

Many empirical studies that are related to the estimation of demand for differentiated products have used the Berry, Levinsohn, and Pakes' (hereafter BLP) methodology.[1] In their paper, BLP introduced a variety of discrete choice models ranging from a simple logit model to a full random coefficients model. As in many empirical studies, market demand is derived from a general class of discrete choice models of individual consumer behavior. Their primary method for estimating the demand for differentiated products, using discrete choice models, assumes that each consumer's utility for products in a market depends upon the characteristics of the product and the consumer's tastes. Each consumer is assumed to purchase one unit of the good that has the highest utility and may choose to purchase an outside good instead of an "inside" product. Then, product level market demands are derived as the

[1]See Berry [1994], Berry et al. [1995].

aggregate outcome of consumer decisions in the absence of observing individual consumer purchase decisions to estimate the demand parameters. This proposed estimation method explicitly allows for the possibility that prices are correlated with unobserved demand factors, such as style, consumers perceptions about quality, durability, and brand reputation, which are inherently difficult to quantify into variables that can be included in the analysis. It is well known that ignoring the correlation between price and omitted demand determinants may lead to biased estimates and even sometimes lead to improbable upward sloping demand curves.

Among a variety of discrete choice models, the nested logit model may be used to describe the demand structure of the domestic air travel industry in Korea. I apply the nested logit model to two types of city pair markets in Korea, which are city pairs for flying to and from Jeju island and inland city pairs. These differ in both types of travelers and in alternatives to air transportation. Jeju island routes are primarily for vacation travelers, but, inland routes attract a great numbers of business travelers. Thus, there are *a priori* expectations of differences in air travel demand sensitivity to price and other factors, such as airtime duration and aircraft types. And in terms of outside goods, domestic city pair traveling on inland routes may be undertaken using alternative travel modes such as rail or bus service, whereas there is no closely comparable ferry service to Jeju island. I examine the nested logit demand model to estimate demand parameters and marginal costs in imperfectly competitive markets from two perspectives: Pre- and post- deregulation, to search for systematic patterns over time.

The rest of this dissertation is organized as follows. The rest of chapter 1 explains the implementation and effects of the deregulation act on the Korean airline industry. The issues in the air travel industry - route specific preference over departure times - are also introduced. Chapter 2 outlines the basic framework of the nested logit model and describes the empirical specification of the air travel demand. In this chapter, the variables used in the model are defined and I provide summary statistics for the panel data from June 2006 to October 2010, two years before and after the Deregulation Act of May 2008. The route-by-route estimation results based on three different specifications are presented. Chapter 3 models the supply side and describes legacy carriers' strategic responses to the emergence of LCCs. Chapter 4 integrates the demand- and supply-side in order to derive price elasticities for air travel demand, implied marginal costs, and Lerner indices. Chapter 5 examines inter-firm departure flight times differentiation on the routes. Chapter 6 evaluates the welfare effects due to the entry of LCCs. Finally, I conclude and discuss some problems with extensions of this approach.

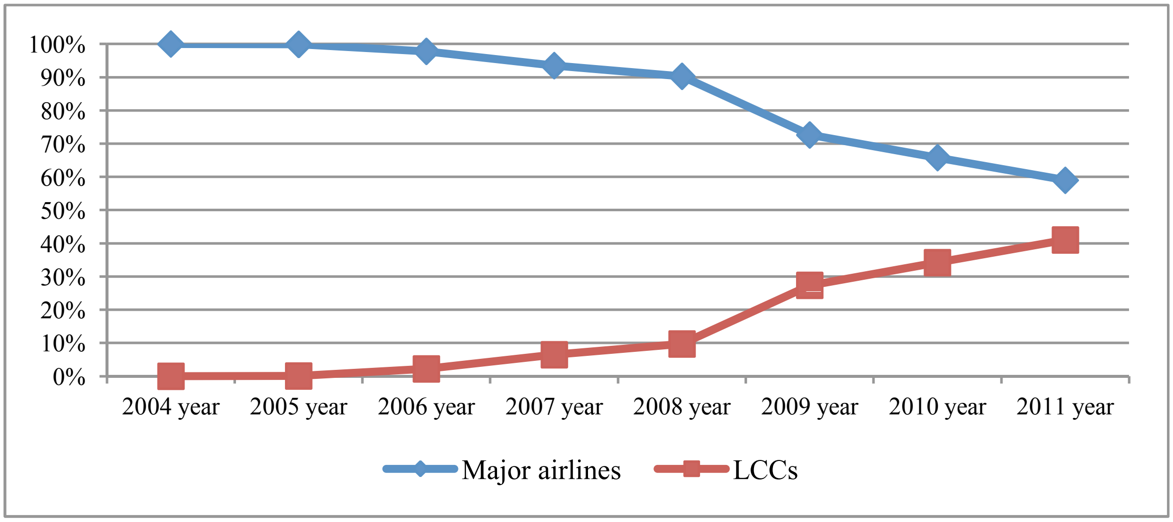
1.1.1 The Korean Airline Industry

Domestic air passenger traffic in Korea has shown a reversal in growth since it picked up around a 16% annual growth rate in the late 1980's and early 1990's. On the other hand, international air passenger traffic has been increasing since the Severe Acute Respiratory Syndrome (SARS) epidemic had a severe negative effect on Asian air travel markets in 1998 and the economic crisis swept across the nation in the late 1990s. While two legacy carriers, KAL and AAR, target international routes instead of pursing relatively low profits in domestic routes following the introduction of high-speed rail services, Korean Train eXpress (KTX), in 2004, LCCs have emerged and entered some domestic city pair markets. In 2005, the first LCC, Hansung Airlines (HAN), received its Air Operator's Certificate (AOC), thus formally approved with the delivery of ATR-72 turboprop aircraft with 78 available seats. Since then the volume of passengers using LCCs had been growing at a faster pace than before in the Korea domestic airline markets which were characterized by duopolies: KAL and AAR. As shown in Figure 1.1,[2] competition in some of the domestic airline markets, long dominated by KAL and AAR, has intensified over the past few years as a growing number of low cost carriers (LCCs) have begun to offer tickets at 70 to 80 percent of the price offered by these legacy carriers, showing considerable growth of market share over the past few years. In the six months prior to June 2011, aggregate domestic market shares of LCCs were about 40%, a new record for LCC penetration in the North Asian nation, making a significant rise from 9.7% in 2008.[3]

[2]Data source: The Ministry of Land, Transport and Maritime Affairs

[3]Source: Centre for Asia Pacific Aviation & OAG Facts, See appendix Figure 2.

Figure 1.1: Percentage of domestic flight shares operated by LCCs (including both independent LCCs and dependent LCCs) and Legacy carriers by year



While it is difficult to formally define low cost carriers (LCCs), any definition should be categorized into two types from the view point of ownership; independent LCCs and dependent LCCs. First, independent LCCs refer to LCCs that are not owned by full service legacy carriers. Pure LCCs or true LCCs may also refer to independent LCCs. Second, dependent LCCs refer to LCCs that are wholly-owned LCC subsidiaries of legacy carriers. Unlike independent LCCs, Dependent LCCs may have code-share flights with their parent company on a specific route. In response to the emergence of independent LCCs, both legacy carriers rebadged and entered some city pair routes with their own LCCs since October 2008. KAL is a parent company of Jin Air (JNA) and AAR is a parent company of Air Busan (ABL). As shown in Figure 1.1, the volume of traffic by LCCs including both independent LCCs and dependent LCCs has rapidly grown relative to that of the two major airlines from 2008 to 2009.

Beyond the supply side perspective of the impact of LCCs' entry on Korean airline markets, "a five-day work week" was introduced for Korea. The National Assembly cleared a legislative bill to amend the Labor Standard Act (LSA) on August 2003. This amended

LSA introduced a five-day work week by reducing the maximum legal working hours from 44 to 40 per week. Previously, Korean workers had traditionally worked more hours than their counterparts in OECD countries. The average working hours were 2447 in 2001, about 600 hours more than workers in the US, Japan and England. The law imposing a shorter workweek on public sector workers, financial institutions and private companies with more than a thousand employees was passed by the South Korean parliament in 2004. For firms with between 300 and 1000 employees, This amended LSA was effective from July 2005 for firms with between 300 and 1000 employees, and from July 2006 for firms with between 100 and 299 employees. In 2011, South Korean companies of all sizes became required to switch to the five-day work week. The law establishing the five-day work week sought to improve the quality of life for South Koreans.

After officially establishing “a 5-day work week” system in 2004, people’s leisure activities have changed greatly. With having increased leisure hours, employees are highly enthused by the new system, in looking forward to their personal time. Thus, reducing total working hours has led to better quality of family life and higher productivity for employees. A five day work week system, combined with emergence of LCCs, has prompted more people to fly due to substantial reduction in fares.

1.1.2 The Deregulation Act of May 2008: Implementation and Effects

Prior to May 2008 Korean airline regulation had restrictive licensing policies (listed in Table 1.1). This regulation system categorized airline carriers into two types: scheduled air service carriers and non-scheduled air service carriers. While non-scheduled air service carriers were only allowed to operate irregular flight services, scheduled air service carriers could operate regular flight services with a license issued by a government aviation body. Only registration was required to be a non-scheduled air service carrier, but the license was necessary to be a qualified scheduled air service carrier. In order to earn the “license,” airline carriers had to fulfill all required criteria of safety with a record minimum of two years operation with over 20,000 flights without accidents. Non-scheduled air service carriers were only allowed to operate aircraft with less than 80 available seats per airplane and there was a restriction on their fleet age (requiring less than 25 years age limit for each aircraft) as well. These restrictions on non-scheduled air service carriers, combined with irregular flights service, greatly limited their aircraft availability and selection. It forced them to use only small turbo-prop aircraft.

Thus, Korean government legislation enabled the two legacy carriers to dominate domestic markets and allowed them to charge high fares as the government restricted competition from LCCs. Although there were a few independent LCCs serving regional routes before 2008, most of these were non-scheduled air service carriers which were subject to the regulated market policy. In this context, "the license policy" hindered prospective entrants from settling in the market.

Table 1.1: Deregulation Act of May 2008

	Before May 2008		After May 2008	
Regulation system	Scheduled air service	Non-scheduled air service	Domestic service	International service
Requirement	License	Registration		
Aircraft size	No limit	80 seats limit per plane	-	-
Aircraft age	No limit	Less than 25 years	-	-

The two legacy carriers' protected dominant positions in domestic markets came to an end in May 2008. The deregulation act of May 2008 removed restrictions and opened the markets. Restrictions imposed on both aircraft size and aircraft age for the non-scheduled airlines were eliminated so that LCCs were able to operate jet aircraft which had more than 80 seats per airplane. The air transport liberalization has led to substantial traffic growth, carrying more passengers at lower fares. Moreover, it has stimulated LCCs on high volume routes, creating new demand for air services as well as shifting of existing demand away from traditional legacy carriers. In particular, competition among the two legacy carriers and independent LCCs for some of the Jeju island routes has intensified due to the dominance of air transportation for travel to and from Jeju island, the country's largest island and tourist's destination.

Several new LCCs have been established over the last three years even though two of them ceased operations. The survivors are in the process of restructuring; Jeju Air (JJA) permanently removed all four Dash 8 Q400s, turboprop aircraft with 78 available seats per airplane, in June 2010. In an attempt to consolidate the fleet around a single airplane type, JJA took delivery of one Boeing 737 in 2011 on top of its existing a fleet of five B737s. Furthermore, Jeju Air is scheduled to take delivery of three more in 2012 and one more in 2013. Another independent LCC, Eastar Jet (ESR) repeatedly boosted its fleets up to six Boeing 737s in March 2010. This change in competition driven by LCCs has pushed the two legacy carriers to adjust their strategies in order to pursue dominant market positions. Both legacy carriers established their own subsidiary LCCs, competing with the independent LCCs.

1.1.3 Two Legacy Carriers Fined for Anti-Competitive Actions against LCCs as of March 2010

In March 2010, Korea's Fair Trade Commission (FTC) imposed fines on KAL (8.4 million U.S.dollars) and on AAR (549,796 U.S.dollars) for disrupting the operations of newly sprouting LCCs. According to the FTC, both KAL and AAR pressed travel agencies to restrict the ticket sales of the independent LCCs such as JJA, HAN, and ONA, threatening to withhold peak period seats on popular routes and domestic routes to Jeju island. As a result, these independent LCCs had great difficulty in selling tickets for major routes including domestic routes to Jeju island. According to the FTC's statement:

> The airline transportation industry requires massive investment at the initial stage to secure aircraft and other infrastructure. The inability to sell airline tick-

> ets through travel agencies caused great difficulty in their operations and made it hard for them to settle into the market. If they fail to safely settle in the market, new companies are likely to collapse because of the massive initial spending.[4]

Thus, it is of interest to analyze what conditions are necessary for deregulation in Korea to be desirable in order to promote competition among airline carriers and increase consumer welfare, enabling LCCs to operate jet aircraft along with the two major airlines, KAL and AAR. From now on, the period prior to the May 2008 implementation of the act will be referred to as "the pre-deregulation period" and the period after the May 2008 implementation of the act will be referred to as "the post-deregulation period."

1.1.4 Departure Flight Times Differentiation in Airline Competition

In the air travel industry, demand is not perfectly inelastic and potential air passengers' preferred departure times are non-uniformly located over time, i.e., heterogeneous consumers' preferences. The air travel demand models for nonstop Jeju island routes and inland routes should be considered, respectively, because these routes have different alternative transportation modes and types of travelers. Specifically, the Jeju island routes are primarily for vacation travelers and, the inland routes attract a greater number of business travelers. Thus, there are a priori expectations of route-specific differences in air travel demand sensitivity to price and other factors, i.e., passengers' most preferred departure times.

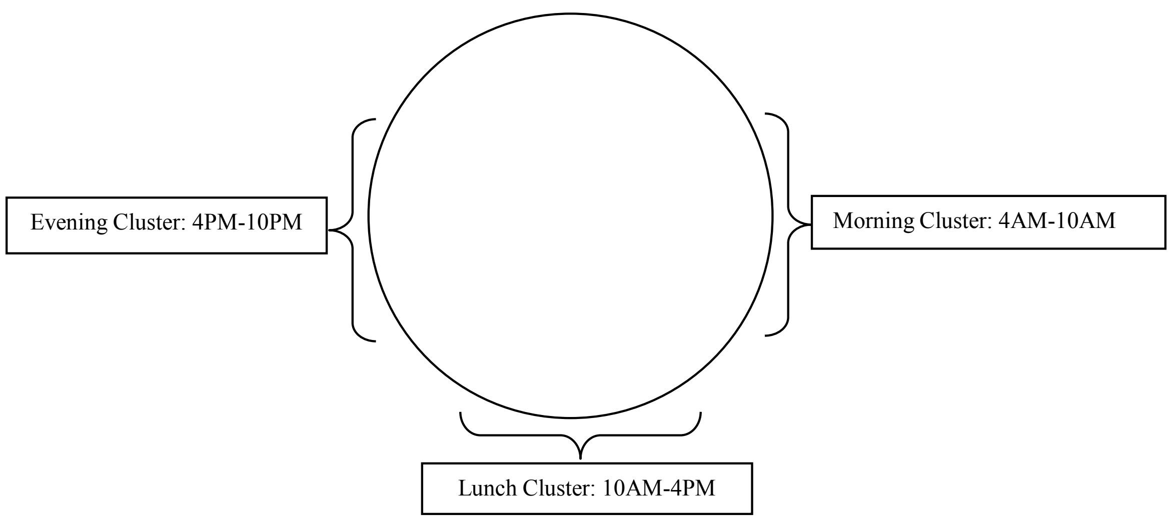
For the Jeju island routes, air travel demand would be high for flights that either depart or arrive during lunch time where time zone change effect is irrelevant in the Korean domestic routes. Vacationers may depart from the island before or around 11AM (noon) as they have to check out of hotels by 11AM. In turn, they would prefer to fly around noon from an origin city in order to arrive at the island around 3PM (4PM) because hotel guests can check in after

[4]The two independent LCCs ceased their operations in 2008: November (HAN) and December (ONA). The Korea FTC statement might have limited the effects of LCCs, for example, the lack of entry to inland routes for the two years following the May 2008 Deregulation Act.

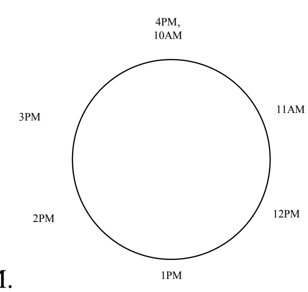
3pm. For the inland routes, business travelers probably differ from vacationers: their most preferred departure times are concentrated into a few hours of a day, either early morning or late night. For business travelers, the mid day flights departing around lunchtime may be virtually irrelevant, but seen as ideal by vacationers who do not want to get up at 5:30AM to make an 8AM flight. Flight timing (e.g., time of day) is an important factor for both types of travelers. Thus, air travel demand for the inland routes will be less for flights that either depart or arrive during lunchtime.

From 10PM to 4AM, I don't observe any flights so I drop these 6 hours from the 24 hour clock. Then, I divide the remaining 18 hours into three clusters: Morning cluster (4AM-10AM), lunch cluster (10AM-4PM), and evening cluster (4PM-10PM) (Figure 1.2).

Figure 1.2: Clustered demand and passengers' preferred departure times



- *Prediction* Departure flight schedules around lunchtime (10AM-4PM) are more evenly distributed in the Jeju island routes than in the inland routes.[5]



[5]Lunch cluster is defined over 6 hour clock: 10AM-4PM.

I expect that vacationers may find flights - either departing or arriving at lunchtime - convenient as their most preferred departure times are concentrated into lunchtime. Thus, air travelers flying to/from Jeju island would experience more utility when departure flight times spread out evenly around lunch time on a route.

In order to capture the degree of departure times differentiation on a route, we need a measure that takes into account how each pair of flight competes with all others on a route. The differentiation index, adapted from the one used by Borenstein and Netz [1999], *DIFF* needs to be modified. $ClusterDIFF$[6] takes a value in the interval $[0,1]$. $ClusterDIFF$ is calculated by using departure times of all non-stop flights. The closer the index to 1, the flights are more evenly distributed over a 6-hour clock, maximizing departure time differentiation. When this index is equal to 0, all flights depart at the same time, meaning no differentiation in departure times.

Table 1.2 reports summary statistics for the average values of the differentiation index, $ClusterDIFF$ and the number of daily flights scheduled at each cluster for the Jeju island routes. From June 2006 to October 2010, two years before and after the deregulation, each

[6] There are n daily direct flights on a route, which depart at $d_1, \dots, d_n$ minutes.

For the morning $ClusterDIFF$, each departing time, $d_1, \dots, d_n$, is expressed as minutes after 4AM. For the lunch $ClusterDIFF$, each departing time, $d_1, \dots, d_n$, is expressed as minutes after 10AM. For the evening $ClusterDIFF$, each departing time, $d_1, \dots, d_n$, is expressed as minutes after 4PM. For example, if one flight is scheduled at 8AM and another is scheduled at 9AM during the morning cluster, $|d_1 - d_2| = |240 - 300| = 60$ is the measure of the departure time difference between the first and second flight during morning cluster.

The average distance between flights is measured as:

$$AVGDIFF = \frac{2}{n(n-1)} \sum_{i=1}^{n} \sum_{j>1}^{n-1} \left[min\left\{ \left| d_i - d_j \right|, 360 - \left| d_i - d_j \right| \right\} \right]^{\alpha}, \; 0 < \alpha < 1$$

where 360 denotes the cluster length in minutes. $AVGDIFF$ is minimized at zero when all flights depart at the same time. $AVGDIFF$ is maximized when flights on a route are evenly distributed over a cluster, 6-hour clock. The power of α denotes the marginal effect of changes in time differences between flights on a route. I arbitrarily choose $\alpha = 0.5$, and the results do not qualitatively change across alternative values of α .

For comparisons of $ClusterDIFF$ across routes with different numbers of flights, $AVGDIFF$ is normalized by the maximum possible departure schedule differentiation, $MAXDIFF$, which is the value when the flights are equally spaced around the 6-hour clock for each cluster.

$$MAXDIFF = \begin{cases} \frac{2}{n(n-1)} \sum_{k=1}^{n/2-1} n \left(k \frac{360}{n} \right)^{\alpha} + \frac{n}{2} \left(180^{\alpha} \right) & , \forall n = even \\ \frac{2}{n(n-1)} \sum_{k=1}^{(n-1)/2} n \left(k \frac{360}{n} \right)^{\alpha} & , \forall n = odd \end{cases}$$

Finally, the measure that is taken to the data is $ClusterDIFF = \frac{AVGDIFF}{MAXDIFF}$.

observation includes direct flights on a route.

Table 1.2: Average cluster differentiation index by route (Jeju island routes)

Route	Pre-deregulation (before May 2008)			Post-deregulation (after May 2008)		
	Morning DIFF # of flights	Lunch DIFF # of flights	Evening DIFF # of flights	Morning DIFF # of flights	Lunch DIFF # of flights	Evening DIFF # of flights
Jeju-Seoul	0.758 14.5	0.979 26.2	0.945 18.4	0.821 19.1	0.987 35.7	0.934 20.8
Jeju-Busan	0.706 4.7	0.942 6.4	0.940 5.8	0.644 4.4	0.961 9.2	0.903 7.0
Jeju-Daegu	0.140 1.4	0.657 2.4	0.893 4.5	0.000 0.4	0.909 4.2	0.886 3.8
Jeju-Gwangju	0.024 0.9	0.931 3.2	0.867 4.0	0.289 2.0	0.857 2.7	0.518 3.0
Jeju-Cheongju	0.382 2.8	0.940 4.8	0.722 3.7	0.421 2.9	0.710 2.4	0.940 6.7

# of flights are rounded.

Table 1.2 gives average daily differentiation index and flight frequency by clusters. As can be seen from the table, several interesting trends are evident. The number of daily flights increased on the Jeju-Seoul, Jeju-Busan route in the post-deregulation period. These increased flight frequency are mainly scheduled over the lunch cluster, thus maximizing lunch cluster departure time differentiation. Specifically, for the Jeju-Seoul route, the number of daily flights during the lunch cluster has risen almost 40 percent during the post-deregulation period. By contrast, the opposite effects are observed on the Jeju-Cheongju and Jeju-Gwangju route in that the number of daily flights has been fairly constant. Flights are more evenly scheduled around either morning (Jeju-Gwangju route) or evening (Jeju-Cheongju). Departure flights scheduling can be constrained by demand-side consideration, i.e., airlines scheduled more flights around lunch cluster on a route where lunchtime demand is high relative to others. Beyond this demand side perspective, each route is a part of a Jeju routes network so airlines may face operational rigidities. Operational rigidities, along with capacity constraints, can pose constraints that affect airlines' strategic responses through schedule differentiation or choices between overall and Jeju route segment profitability for an airline.

Table 1.3 describes the average values of the differentiation index, $ClusterDIFF$ and the number of daily flights scheduled at each cluster for the inland routes. No significant change in the number of flights is observed in the inland routes. Surprisingly, for the Seoul-Busan route, departure flights around the lunch cluster are more evenly distributed than the Jeju island routes.[7]

Table 1.3: Average cluster differentiation index by route (Inland routes)

Route	Pre-deregulation (before May 2008)			Post-deregulation (after May 2008)		
	Morning DIFF # of flights	Lunch DIFF # of flights	Evening DIFF # of flights	Morning DIFF # of flights	Lunch DIFF # of flights	Evening DIFF # of flights
Seoul-Busan	0.787 6.2	0.990 13.2	0.985 11.6	0.837 6.6	0.994 12.7	0.974 10.8
Seoul-Gwangju	0.610 2.2	0.890 2.6	0.912 3.1	0.527 2.0	0.707 2.0	0.746 3.0

# of flights are rounded.

It is not clear to see whether departure flight schedules around lunchtime (10AM-4PM) are more evenly distributed in the Jeju island routes than in the inland routes. Thus, to investigate the effect of lunch cluster departure time differentiation on the air passengers' utility, other factors, i.e., flight characteristics, seasonality effect, etc., also need to be controlled (chapter 2).

[7]See appendix Table15. For the other inland routes, no significant changes in the number of flights are observed.

Chapter 2

Modeling the Demand Side

2.1 Theoretical Model

The demand model starts from the specification of a discrete choice model. The utility of consumer i for product j depends on the characteristics of the product and the consumer.

$$U\left(X_j, z_i, \xi_j, p_j, \varepsilon_{ij}; \alpha_i, \beta_i\right)$$

where X_j,z_i, ξ_j, p_j and α_i, β_i are observed product characteristics of product j, socio-economic variables of individual consumer i, unobserved product characteristics of product j, the price of product j and demand parameters, respectively. The random term ε_{ij} captures the consumer's specific tastes, which are assumed to be identically and independently distributed across consumers and products. Different assumptions about the distributions of the random term and the demand taste parameters have important implications for the resulting model. In a simple logit model,[1] individual consumer i has the same coefficients for price and product characteristics. This means the consumer's specific taste parameters for price, $\alpha_i = \alpha$, and for product attributes, $\beta_i = \beta$, are written as invariant across consumers, $i = 1, 2 \ldots, I$.

[1] The multinomial logit model and its extension as developed by McFadden (1973, 1974, 1976a, 1978, 1979, 1982).

The simple logit model is derived on the assumption that the random terms ε_{ij} in the utility function have independent extreme-value distributions. The following consequence of the assumption that the variation in consumer tastes enters only through the additive term ε_{ij} places very strong restrictions on the pattern of cross- price elasticities from the estimated demand model in a simple logit model. In particular, the substitution pattern among products is completely driven by market shares, not by how products are similar in physical attributes.

In contrast, the nested logit model relaxes this restrictive assumption that consumer heterogeneity only enters through the additive term ε_{ij} while maintaining the advantage of a simple logit model in tractability, $\alpha_i = \alpha$, and $\beta_i = \beta$. A group of similar alternatives is called a nest and each alternative belongs to exactly one nest. The key specification idea of the nested logit model is the way in which the consumer's specific taste term is entered in the utility function. It allows the consumer's utility to be correlated among products belonging to the same nest where higher substitution patterns are supposed to exist between products belonging to the same segment or nest. An increase in the price of product j affects some consumers who currently purchase good j so that these consumers will substitute similar products within the same nest. The nested logit model is derived from the assumption that the random terms ε_{ij} have a generalized extreme-value distribution; thereby, a general pattern of dependence among the choices only within the same nest is allowed, avoiding the IIA (Independence of Irrelevant Alternatives) property.[2]

[2]The restrictions imposed by the IIA property of a simple logit model are very unappealing in many applications. The model with the IIA property predicts too high a joint probability of selection for two alternatives that are in fact perceived as similar rather than independent by the individual consumer$i$. For instance, commuters initially face a decision between two modes of transportation: red bus and auto. Suppose commuters choose these two options with equal probability, 0.5, so that the odds ratio equals 1. Now a third mode, blue bus, is added and commuters treat the two buses as equivalent. They are expected to choose between bus and car still with equal probability, so the probability of car is still 0.5, while the probabilities of each of the two bus types is 0.25. Suppose X_1,X_2, and X_3 are the attributes of a trip by red bus, blue bus, and auto, respectively.Then, one expects

$$P\left(Red\,bus\,|\,X_1, X_2\right) = P\left(Red\,bus\,|\,X_1, X_3\right) = P\left(Blue\,bus\,|\,X_2, X_3\right) = 1/2$$

and

$$P\left(Red\,bus\,|\,X_1, X_2, X_3\right) = P\left(Blue\,bus\,|\,X_1, X_2, X_3\right) = 1/4$$

The relative odds of alternatives 1 and 3 depend on the presence of alternative 2. They are 1 : 1 if choice

In the present application, I follow Cardell's (1991) exposition of the nested logit model; the statistical properties of the distribution that the random terms ε_{ij} have to follow in order to obtain a model consistent with the results in McFadden (1981).

2.2 Empirical Model

I apply the nested logit model to two types of city pair markets in Korea. There are city pairs for flying to and from Jeju island and inland city pairs. These differ in both types of travelers and in alternatives to air transportation. Jeju,[3] located off of the southern coast of mainland South Korea, is an island whose weather is mild even in winter season and is a famous resort. Every year, over 4 million visitors from mainland Korea, Japan, and China arrive at the island through the airport. Jeju island routes are primarily for vacation travelers, while inland routes attract a great numbers of business travelers. Thus, there are *a priori* expectations of differences in air travel demand sensitivity to price and other factors, such as airtime duration and aircraft types. And with respect to outside goods, domestic city pair traveling on inland routes may be undertaken using alternative travel modes such as rail or bus service, whereas there is no closely comparable ferry service to Jeju island. Thus, I would expect α_r and/or β_r to differ by Jeju island routes $(r = 1,2,3,4,5)$ versus inland routes $(r = 6,7)$.[4]

2.2.1 The Air Travel Demand for Jeju Island Routes

Within the Jeju island routes, there are $r = 1,2,3,4,5$ routes; Jeju-Seoul $(r = 1)$, Jeju-Busan $(r = 2)$, Jeju-Cheongju $(r = 3)$, Jeju-Daegu $(r = 4)$, and Jeju-Gwangju $(r = 5)$ route. Assume I

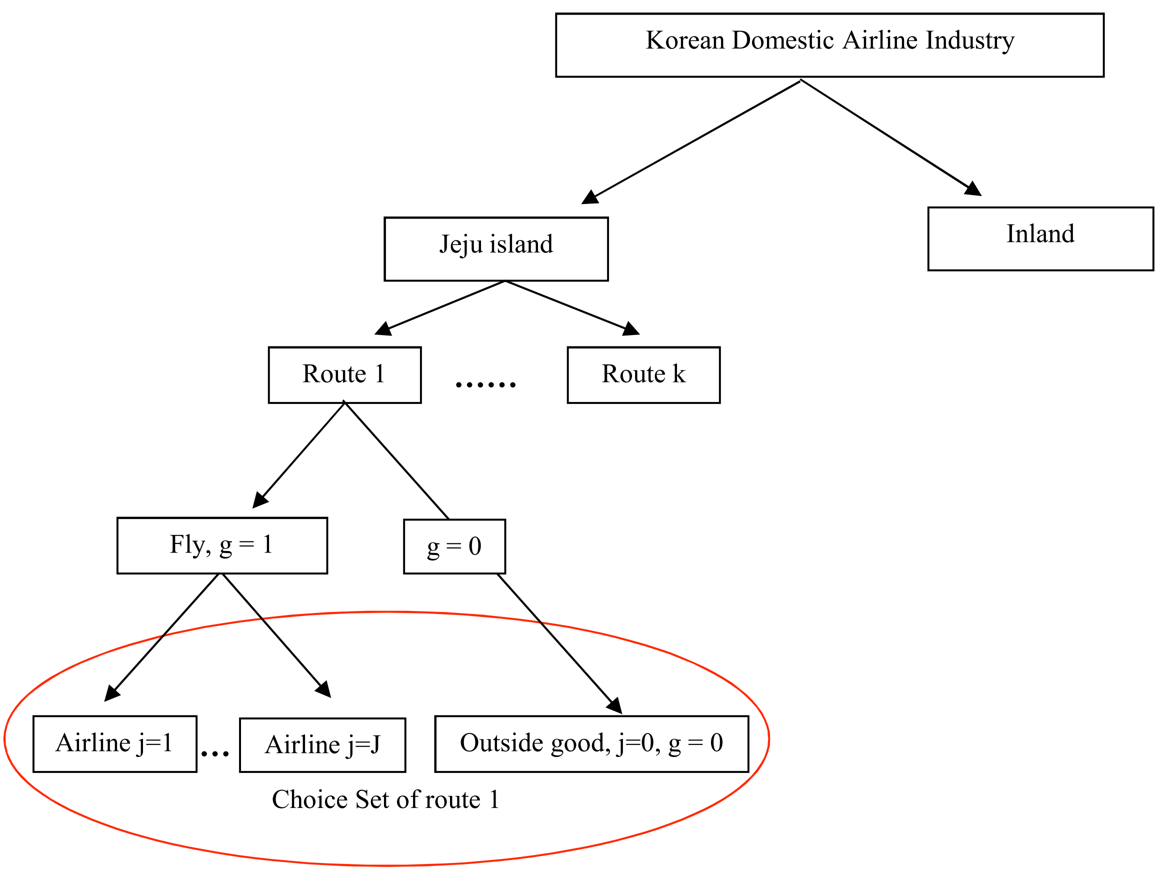
2 is not present. They are 1 : 2 if choice 2 is present. This is inconsistent with the simple logit model. IIA property implies that this is not the case: for the odds ratio between car and red bus to be preserved, the new probabilities must be: car 0.33; red bus 0.33; blue bus 0.33. See Wooldridge 2002, pp. 501-2

[3] See appendix for a map showing location of Jeju and other airport cities in this study.

[4] I limit the sample to routes where a substantial number of passengers fly. In addition, some domestic city pair routes are excluded if data such as fares or aircraft size were missing, or if the number of flights in a given route were less than three.

observe $t = 1, \ldots\ldots, T$ time periods, each with $i = 1, \ldots\ldots, I$ potential air passengers on $r = 1, 2, 3, 4, 5$ Jeju island routes, respectively. I observe data for a cross section of airline specific non-stop flights over 50 months (June 2006 to October 2010). For each time period, I observe monthly aggregate passengers on each route by airline carriers, and product characteristics for $j = 0, 1, \ldots, J$ airline carrier specific non-stop flights. Air passenger i is assumed to choose a flight which gives the highest utility and may choose an outside good instead of an inside good. Then, $j = 0$ represents an outside good, a no flying decision. Time subscripts, t, are included to account for the panel structure of the data.

Figure 2.1: Korean Domestic Air Travel Demand structure: Jeju island routes



The indirect utility obtained by air passenger i flying a city pair route $r = 1,2,3,4,5$ from direct flight j in time t is

$$U^r_{Jeju,igt} = \delta^r_{Jeju,jt} + \zeta^r_{igt+} (1-\sigma_r)\, \varepsilon_{ijt} \ (1)$$

where $\delta^r_{Jeju,jt} = X^r_{Jeju,jt}\beta_r - \alpha_r p^r_{jt} + \xi_{jt}$ measures mean utility levels for direct flight $j = 0,1,\ldots,J$ and $X^r_{Jeju,jt}$ is observed characteristics of non-stop flight j by different airline carriers, ξ_{jt} are unobserved (by the researchers) product characteristics of direct flight j. $g = 0,1$ is a group within a specific route $r = 1,2,3,4,5$. The term ζ^r_{igt} is air traveler i's idiosyncratic tastes for the nests $g = 0,1$ within the individual routes from Jeju island routes, and it captures route specific unobservables. This nested error term is defined over non-stop flights that fly a specific route and is constant within the route. The $j = 0,1,\ldots,J$ flights on a route are nested as two exhaustive and mutually exclusive nests. I consider the specification that only two nests, $g = 0,1$ are present for each route $r = 1,2,3,4,5$, respectively. Thus, route specific flights $j = 0,1,\ldots,J$ are nested into two segments. I categorize inside goods group $g = 1$ as one nest, and an outside good group $g = 0$ as another nest in which only the non-buying option, $j = 0$ is available. Individuals' heterogeneity enters the model through the random part of utility $\left[\zeta^r_{igt} + (1-\sigma_r)\,\varepsilon_{ijt}\right]$ and in particular, the term $(1-\sigma_r)\,\varepsilon_{ijt}$ captures the idiosyncratic preference for direct flight j. The nesting parameter σ_r lies between 0 and 1, which measures the correlation of the air passengers' utilities across flights compared with the potential fliers who did not choose air travel at time t. As σ_r goes to 1, flights operated by different carriers are perceived as perfect substitutes. The variable ε_{ijt} is an individual i specific unobservable.

The specification of the demand in this discrete choice model is finished with an outside good. By construction, in the current framework, the relative prices along with flight attributes, such as aircraft size and flight frequency, and/or brand reputation determine the probabilities of choosing a flight $j = 0,1,......,J$, conditional upon the decision to fly. The outside good $j=0$ is assumed to be the only member of $g=0$, normalizing the utility from the outside good to zero, $U^r_{Jeju,i0t}=0$. The existence of the outside good allows air passengers to choose none of the inside goods. The outside good serves as a unit of account to measure the worth of different inside goods relative to one another; for instance, it is a numeraire good and is used in normalizing the mean utility level of flight $j=0,1,......,J$. I define a market as a nonstop route air travel market at time t; therefore, there are route specific outside goods which vary over time. In particular, I define the route specific outside goods that are proportional to population and Gross Regional Domestic Product (GRDP) per capita of origin cities, and enplanement of the route (Table 2.1).

Table 2.1: Data to be used to construct the route specific outside good

Origin city	Seoul	Busan	Daegu	Cheongju	Gwangju
Population	10,218,943	3,571,903	2,496,152	501,959	1,426,444
GRDP (US $BN)	222.70	48.96	29.12	9.20	20.25
GRDP per capita (US $)	21792.9	13708.4	11667.6	18320.1	14194.4

Given the functional form assumptions that if both ε_{ijt} and $\left[\zeta^r_{igt}+(1-\sigma_r)\,\varepsilon_{ijt}\right]$ follow a type I extreme value distribution with $0<\sigma<1$,[5] the discrete choice route specific market share function is derived[6]

$$s_{jt}=\frac{exp\left(\delta^r_{Jeju,jt}/1-\sigma_r\right)}{D_g^{\sigma_r}\left[\sum_g^{g=0,1}D_g^{(1-\sigma_r)}\right]} \quad (2)$$

where $g=1$ represents making the choice to fly on a specific route, $g=0$ represents a no flying decision and $D_g\equiv\sum_{j\in g}^{g=0,1}exp\left(\delta^r_{Jeju,jt}/(1-\sigma_r)\right)$. $\delta^r_{Jeju,jt}=X^r_{Jeju,jt}\beta_r-\alpha_r p^r_{jt}+\xi_{jt}$ is the

[5] Air passengers are assumed to purchase the flight that gives the highest utility in time$t$.

[6] See Berry [1994] for a complete version of the derivation; If product j is in group g, the well known formula for the market share of product j as a fraction of the total group share is $s_{j/g}=e^{\delta_j/(1-\sigma)}/D_g$, where the denominator of this expression for a product in group g is $s_g=D_g^{(1-\sigma)}/\left[\sum_g D_g^{(1-\sigma)}\right]$, giving a market share of $s_j=sj/g\cdot s_g=e^{\delta_j/(1-\sigma)}/D_g^{\sigma}\left[\sum_g D_g^{(1-\sigma)}\right]$.

mean utility for non-stop flights $j = 1, \ldots, J$. In order to apply the standard instrumental variable method, a linearly transformed demand equation proposed by Berry (1994) is used with the data for each city pair route $r = 1, 2, 3, 4, 5$, separately.

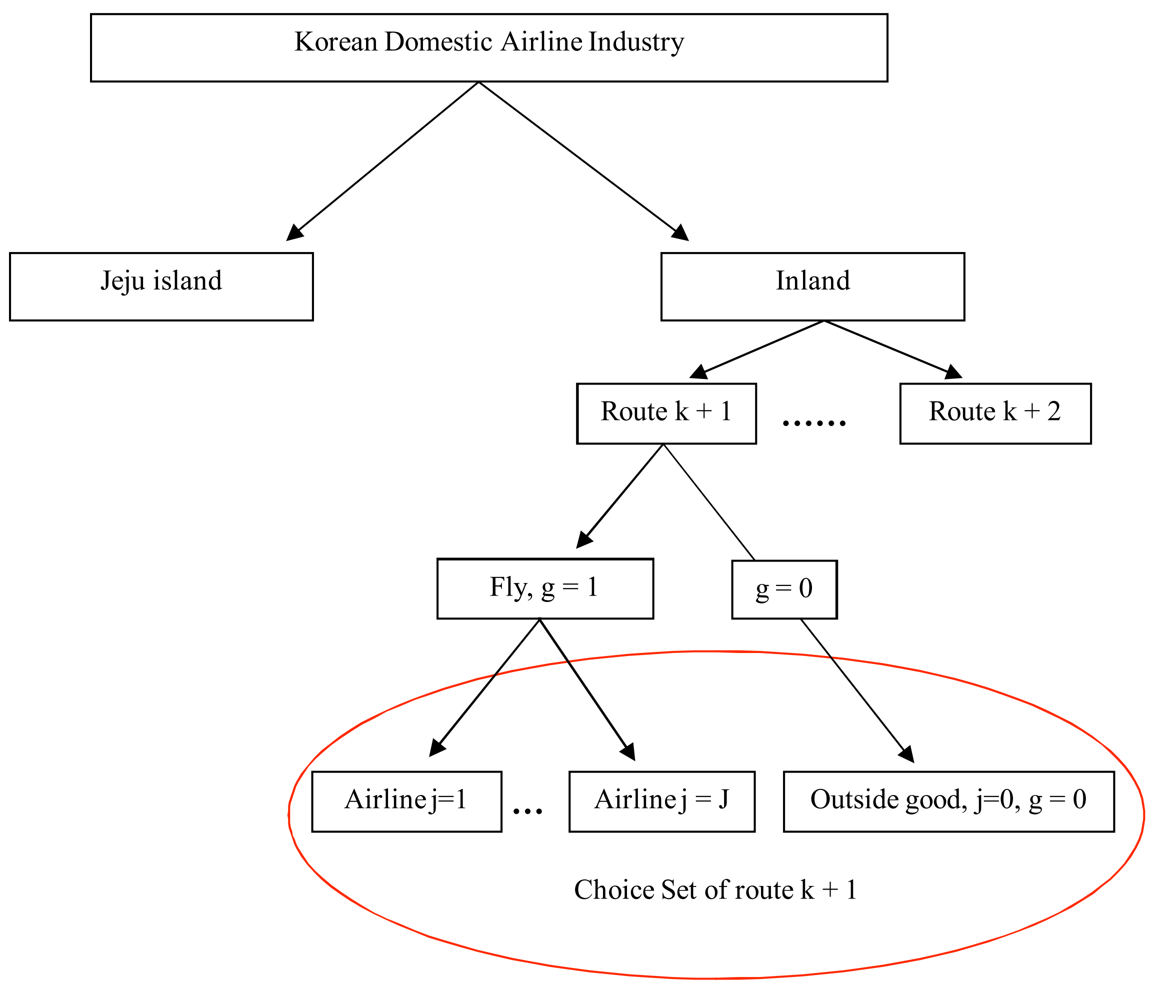
$$ln\left(s_{jt}\right) - ln\left(s_{0t}\right) = X^{r}_{Jeju,jt}\beta_r - \alpha_r p^{r}_{jt} + \gamma_r z_{it} + \sigma_r ln\left(s_{jt/gt}\right) + \xi_{jt} \quad (3)$$

where s_{jt} is the market share of flight j at time t, and s_{0t} is the market share for the outside good. $s_{jt/gt}$ is the within the flying nest $(g = 1)$ share of flight j and is calculated by dividing total passengers carried by each airline carrier by the total passengers of the flying inside goods. $X^{r}_{Jeju,jt}$ includes not only observed product characteristics such as aircraft size, airtime duration, and service flight frequency, but also meteorological data of Jeju island to capture seasonality in Jeju's air travel industry. p^{r}_{jt} is the air fare of flight j, and a socio-economic variable z_{it} describes characteristics of the decision makers, air traveler i. Here, I use Gross Regional Domestic Product (GRDP) per capita of origin cities in order to capture regional consumer heterogeneity.

The correlation of p^{r}_{jt} with ξ_{jt}, the econometric error term, suggests the use of instruments for prices. In addition, there is another endogenous variable in the demand: $ln\left(s_{jt/gt}\right)$, the within group market shares, by construction. The set of instruments and their validity are discussed in a later section.

2.2.2 The Air Travel Demand for Inland Routes

Figure 2.2: Korean Domestic Air Travel Demand structure: Inland routes



Within inland routes, there are two routes $(r = 6, 7)$;[7] Seoul-Busan $(r = 6)$ and Seoul-Gwangju $(r = 7)$. Assume I observe $t = 1, \ldots\ldots, T$ time periods, each with $i = 1, \ldots\ldots, I$ potential air passengers on $r = 6, 7$ inland routes, respectively. I observe data for a cross section of airline specific non-stop flights over 50 months (June 2006 to October 2010). Air

[7]Some domestic city pair routes are excluded if data such as fares or aircraft size were missing, or if the number of flights in a given route were less than three. These routes include the Seoul-Daegu, the Seoul-Pohang, and the Seoul-Ulsan city pair markets, which have no LCCs entry during the sample time period.

passenger i is assumed to choose a flight which gives the highest utility and may choose an outside good instead of an inside good. Then, $j=0$ represents an outside good, a no flying decision. Time subscripts, t, are included to account for the panel structure of the data. The indirect utility obtained by air passenger i flying a route $\forall r=6,7$ from direct flight j in time t is

$$U^r_{Inland,igt} = \delta^r_{Inland,jt} + \zeta^r_{igt+} \left(1-\sigma_r\right) \varepsilon_{ijt} \ (4)$$

where $\delta^r_{Inland,jt} = X^r_{Inland,jt}\beta_r - \alpha_r p^r_{jt} + \xi_{jt}$ measures mean utility levels for direct flight $j=0,1,\ldots,J$ and $X^r_{Inland,jt}$ is observed characteristics of non-stop flight j by different airline carriers, ξ_{jt} are unobserved (by the researchers) product characteristics of direct flight j. $g=0,1$ is a group within a specific route $r=6,7$. The term ζ^r_{igt} is air traveler i's idiosyncratic tastes for the nests $g=0,1$ within the individual routes from inland routes, and it captures route specific unobservables. This nested error term is defined over non-stop flights that fly a specific route and is constant within the route. The $j=0,1,\ldots,J$ flights on a route are nested as two exhaustive and mutually exclusive nests. I consider the specification that only two nests, $g=0,1$ are present for each route $r=6,7$. respectively. Thus, route specific flights $j=0,1,\ldots,J$ are nested two into segments. I categorize inside goods group $g=1$ as one nest, and an outside good group $g=0$ as another nest in which only the non-buying option, $j=0$ is available. Individuals' heterogeneity enters the model through the random part of utility $\left[\zeta^r_{igt} + \left(1-\sigma_r\right)\varepsilon_{ijt}\right]$ and in particular the term $\left(1-\sigma_r\right)\varepsilon_{ijt}$ captures the idiosyncratic preference for direct flight j. The nesting parameter σ_r lies between 0 and 1, which measures the correlation of the air passengers' utilities across flights compared with the potential fliers who didn't choose air travel at time t. As σ_r goes to 1, flights operated by different carriers are perceived as perfect substitutes. The variable ε_{ijt} is an individual i specific unobservable.

The specification of the demand in this discrete choice model is finished with an outside good. By construction, in the current framework, the relative prices along with flight attributes, such as aircraft size and flight frequency, and/or brand reputation determine the probabilities of choosing a given flight conditional upon the decision to fly. The outside good $j=0$ is assumed to be the only member of $g=0$ and the existence of the outside good allows air passengers to choose none of the inside goods. The outside good serves as a unit of account to measure the worth of different inside goods relative to one another; for instance, it is a numeraire good and is used in normalizing the mean utility level of flight $j=0,1,......,J$. I define a market as a nonstop route air travel market at time t; therefore, there are route specific outside goods which vary over time. Especially, I define the route specific outside goods that are proportional to population and Gross Regional Domestic Product (GRDP) per capita of origin cities, and enplanement of the route (Table 2.1).

Given the functional form assumptions that if both ε_{ijt} and $\left[\zeta_{igt}^{r}+(1-\sigma_r)\,\varepsilon_{ijt}\right]$ follow a type I extreme value distribution with $0<\sigma<1$,[8] the discrete choice route specific market share function is derived[9]

$$s_{jt}=\frac{exp\left(\delta_{Inland,jt}^{r}/1-\sigma_r\right)}{D_g^{\sigma_r}\left[\sum_g^{g=0,1}D_g^{(1-\sigma_r)}\right]}\ (5)$$

where $g=1$ represents making the choice to fly on a specific route, $g=0$ represents a no flying decision and $D_g\equiv\sum_{j\in g}^{g=0,1}exp\left(\delta_{Inland,jt}^{r}/(1-\sigma_r)\right)$. $\delta_{Inland,jt}^{r}=X_{Inland,jt}^{r}\beta_r-\alpha_r p_{jt}^{r}+\xi_{jt}$ is the mean utility for non-stop flights $j=1,\ldots,J$. In order to apply the standard instrumental variable method, a linearly transformed demand equation proposed by Berry (1994) is used with the data for each city pair route $\forall r=6,7$, separately.

$$ln\left(s_{jt}\right)-ln\left(s_{0t}\right)=X_{Inland,jt}^{r}\beta_r-\alpha_r p_{jt}^{r}+\gamma_r z_{it}+\sigma_r ln\left(s_{jt/gt}\right)+\xi_{jt}\ (6)$$

where s_{jt} is the market share of flight j at time t and s_{0t} is the market share for the outside good. $s_{jt/gt}$ is the within the flying, $g=1$, nest share of flight j and is calculated dividing total

[8]Air passengers are assumed to purchase the flight that gives the highest utility in time t.
[9]See Berry [1994] for a complete version of this derivation.

passengers carried by each airline carrier by the total passengers of the flying inside goods. $X^r_{Inland,jt}$ includes the observed product characteristics such as aircraft size, airtime duration, and service flight frequency. p^r_{jt} is the air fare of flight j and a socio-economic variable z_{it} describes characteristics of the decision makers, air traveler i. Here, I use Gross Regional Domestic Product (GRDP) per capita of origin cities in order to capture regional consumer heterogeneity.

The correlation of p^r_{jt} with ξ_{jt}, the econometric error term, suggests the use of instruments for prices. In addition, there is another endogenous variable in the demand: $ln\left(s_{jt/gt}\right)$, the within group market shares, by construction. The set of instruments and their validity are discussed in a later section.

2.2.3 Joint Constraints Jeju island, Inland, and All Routes

First, if there are *a priori* expectations of no differences in terms of demand sensitivity to price within the Jeju island routes, I would expect the fare coefficient α to be the same across the Jeju island routes. The null hypothesis, $H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5$, a common sensitivity to price, $\alpha_{Jeju} = \alpha_r, \forall r = 1,2,3,4,5$ for the Jeju island routes in eq(3), will be tested in a later section.

Second, if there are *a priori* expectations of different air travel demand sensitivities to flight characteristics, such as flight frequency, aircraft size, and airtime duration within the Jeju island routes, I would expect the flight characteristics to have different effects for different routes. In particular, the null hypothesis, $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$, will also be tested in a later section.

Third, if there are *a priori* expectations of no differences in terms of demand sensitivity to price within the inland routes, I would expect the fare coefficient α to be the same across the inland routes. The null hypothesis, $H_0 : \alpha_6 = \alpha_7$, a common sensitivity to price, $\alpha_{Inland} = \alpha_r, \forall r = 6,7$ for the inland routes in eq(6), will be tested in a later section.

Forth, if there are *a priori* expectations of different air travel demand sensitivities to flight characteristics, such as flight frequency, aircraft size, and airtime duration within the inland routes, I would expect the flight characteristics to have different effects for different routes. In particular, the null hypothesis, $H_0 : \beta_6 = \beta_7$, will also be tested in a later section.

Finally, the Jeju island routes and the inland routes have different alternative transportation modes and types of travelers. For the inland routes, alternatives include bus, rail, and automobile transportation. To get to Jeju island, however, the ferry is really not a viable option. And with respect to types of travelers, the Jeju island routes are primarily for vacation travelers, and the inland routes attract a greater number of business travelers. Even though there are *a priori* expectations of different air travel demand sensitivity to price between the Jeju island routes and the inland routes, the joint equality test for the fare coefficients across the Jeju island routes and the inland routes, $H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 \left(\alpha_{Jeju} = \alpha_{Inland} = \alpha_r \, \forall r = 1,2,3,4,5,6,7\right)$ will be conducted for completeness.

2.2.4 Instruments

The potential correlation of p^r_{jt} with ξ_{jt}, the econometric error term, suggests the use of instruments for prices p^r_{jt}. We construct two sets of instruments based on two strategies used in the literature. In addition, there is one more endogenous variable in the demand specification: $ln\left(s_{jt/gt}\right)$, the within group market shares, by construction. The ideal instrumental variables in the nested logit demand are ones that shift costs but do not directly enter the demand equation (3) for the Jeju island routes (route specific α_r and β_r), and the demand equation (6) for inland routes (route specific α_r and β_r). There are two different sets of instruments: Berry, Levinsohn, and Pakes (BLP) style and Hausman panel style instruments.

First, the physical characteristics of the products can be adapted as BLP style instruments (SeeVerboven [1996], Bresnahan et al. [1997], and Petrin [2002]). All observed product characteristics are exogenous with respect to the unobservable product characteristics. If airline carriers are assumed to choose the attributes of some route specific features, for example, the service flight frequency and aircraft size first, and then set the prices later, the product characteristics can be assumed to be exogenous given that the researchers only observe the price-setting decisions. Given this assumption that the unobserved product characteristics ξ_{jt} are only observed by both air passengers and airline carriers (not observed by researchers), the characteristics of other firms' flights k, $X^r_{Jeju,kt}$ for the Jeju island routes, or $X^r_{Inland,kt}$ for the inland routes, such as flight frequency, airtime duration and aircraft size, are appropriate instruments. These are adequate because they are excluded from the utility function for taking flight j while they are correlated with prices through the markups in the pricing equation. The indirect utility of air passenger i from flight j by different airline carriers in time t entirely depends on mean utility levels for direct flight j, not flight k ($\delta^r_{Jeju,jt} = X^r_{Jeju,jt}\beta_r - \alpha_r p^r_{jt} + \xi_{jt}$, $\forall r = 1,2,3,4,5$ for the Jeju island routes or $\delta^r_{Inland,jt} = X^r_{Inland,jt}\beta_r - \alpha_r p^r_{jt} + \xi_{jt}$, $\forall r = 6,7$, for the inland routes).

Second, Hausman panel style instruments, first introduced by Hausman et al. [1994], are considered as well. It appears quite a few papers use these types of instruments. The main idea of Hausman instruments is that prices in other geographic markets in the panel can be employed as instruments for prices in a particular geographic market, as underlying cost shocks ought to affect prices in all geographic locations. An obvious underlying costs variable would be fuel costs or climate changes, creating the necessary exogenous variation in prices. The prices of the other Jeju routes $r = 2,3,4,5$ are considered to be correlated with the price of a route $r = 1$ flying to and from Jeju island and similarly for each of the other four Jeju island routes. It is also reasonable to believe that the prices of the other inland route $r = 7$ would be instrumenting for price of an inland route $r = 6$ and vice-versa.

2.2.5 Panel Fixed Effect Estimator for Unobserved Product Characteristics, ξ_{jt}

Each flight operated by different carriers will be assumed to have a characteristic that influences demand, but that either is not observed by the researcher or cannot be quantified into a variable, such as brand reputation of specific airline carriers $f = 1, ..., F$. The model that is used with the data is a static panel data model where airline carrier- and time-specific characteristics can be controlled. The error term $\xi_{jt} = \xi_f + \xi_t + \Delta\xi_{jt}$ has an error component structure: individual airline carrier effects, ξ_f, and simultaneity effects, ξ_t. In the panel data structure, the airline carrier specific terms ξ_f absorb any firm fixed effects, for example, brand reputation or images associated with each airline carriers, which are assumed to be constant across times. Furthermore, the set of time dummies in the model ξ_t controls for the time invariant effects. Thus, the remaining error term is $\Delta\xi_{jt} = \xi_{jt} - \xi_f - \xi_t$. This error term varies across time and individual products $j = 0, 1 \ldots, J$ and is assumed to be serially uncorrelated. The two endogenous variables, p^r_{jt} and $ln\left(s_{jt/gt}\right)$, need to be instrumented given their potential correlation with this remaining error term.

2.3 Data

I merged data from several sources.[10] The data consist of monthly fares and total monthly passengers of domestic city pair non-stop flights of each route during the 52 months between June 2006 and Oct 2010. Airfares are different across peak or off-peak periods and airline carriers are required by law to announce fare information in advance. For the same route served by the same airline carrier, fares are lower during off-peak seasons than during peak-seasons. Peak-seasons also can be categorized into two types: August and semi-peak months

[10]Korea Airports Corporation (KAC) www.airport.co.kr
Statistics Korea www.kostat.go.kr
Jeju Special Self-Governing Provincial Tourism Association www.hijeju.or.kr

of January, April, May, July and October.[11]

The dataset was then completed by information on aircraft size (number of available seats per plane), airtime duration in minutes, aircraft types, turbo prop or not, and total monthly service flight frequency. These additional data were collected from each carrier's website.[12] In order to capture regional consumers' income, monthly Gross Regional Domestic Product (GRDP) per capita of origin cities are collected, because all city pair routes of the Jeju island routes (Seoul, Busan, Cheongju, Daegu, and Gwangju) are flying to Jeju island and those of the inland routes (Busan, Gwangju) are flying to Seoul and vice versa. In particular, the dataset for the Jeju routes was supplemented with monthly meteorological data for Jeju island such as precipitation (mm), average temperatures, and number of snow days, thus controlling for seasonality in Jeju airline travel demand.

Recall the demand equation for the Jeju island routes, $r = 1,2,3,4,5$ in equation (3) and that for the inland routes, $r = 6,7$ in equation (6). The only differences between $X^r_{Jeju,jt}$ (explanatory variables for flight j flying the Jeju routes, $\forall r = 1,2,3,4,5$) and $X^r_{Inland,jt}$ (explanatory variables for flight j flying the inland routes, $\forall r = 6,7$) are the meteorological factors of Jeju island. For the Jeju island routes, I would expect the meteorological factors to capture strong seasonality effects of the air travel demand and also capture Jeju specific effects along with time fixed effects. Unlike the Jeju island route, these additional Jeju island explanatory variables should not have effects on the inland routes. Table 2.2 describes the available variables. Along with the lunch $ClusterDIFF$[13]variable discussed in chapter 1, all

[11] January and October are holiday season. July and August are summer vacation/tourist season. Elementary school, middle school, and high school schedule educational field trips in April and May. Data source: Jeju Special Self-Governing Provincial Tourism Association

[12] Korean Air http://kr.koreanair.com/
Asiana Air http://flyasiana.com/
Hansung Air (Hansung Air ceased operation).
Jeju Air http://www.jejuair.net/
Yeongnam Air (Yeongnam Air ceased operation).
Jin Air http://www.jinair.com/
Air Busan http://www.airbusan.com/
Eastar Jet http://www.eastarjet.co.kr/
Tway Air http://www.twayair.com/

[13] See Tables 1.2 and 1.3 in section 1.1.4.

variables defined in Table 2.2 are taken to estimation.

Table 2.2: Descriptions of the explanatory variables (time subscripts and route superscripts are omitted)

Variable	Description
Fare	Average monthly air fares including fuel surcharges expressed in 2005 dollars (US \$). Fares do not incorporate any coupons or discounts.
s_{jt}	Monthly market shares for each flight j on a route are computed as total passengers divided by the market size, inside good plus outside good.
$s_{jt/gt}$	Within market shares are computed dividing total passengers carried by each airline carrier by the total passengers of a route.
Flights frequency	Monthly total flights by each airline carrier on a specific route
Flight air time duration	Flight duration in minutes for a route
Aircraft (A/C) size	Average number of available seats per plane on flight j of airline k on a route
August dummy	1 if August, 0 otherwise
Semi-peak dummy	1 if Jan, April, May, July, and October, 0 otherwise
Regional GRDP per capita	Monthly GRDP per capita in US \$ of origin cities
Meteorological variables	Monthly precipitation (mm), number of snow days

Market shares are defined using a quantity variable, which depends on the context. The most important consideration in choosing the quantity variable is the need to define a market share for the outside good. For each non-stop route, I define a market as a route in time t. Market size is defined as the number of passengers (the inside good) plus potential fliers making a no flight decision (outside good). This varies across time and routes. Based on the yearly reports by the Jeju Special Self-Governing Provincial Tourism Association, the average volume of air travelers given each route is calculated first. Thus, a time- and route-specific outside good is proportional to the average volume of air travelers for a specific route and population size.[14]

[14]The demand estimation results are qualitatively insensitive to the choice of time- and route-specific outside goods, at 0.01% to 0.5% of population for origin cities. That is, the choice of time- and route- specific outside

Greater choices of flights frequency would give higher utility for air travelers. The shorter air time duration is, the more an air traveler would enjoy the service. The longest flight in Korean domestic routes is the one flying the Jeju-Seoul route and it only takes about 65 minutes for jet airplanes and 75 minutes (Dash 8-Q400) or 90 minutes (ATR72) for turboprop airplanes. Except for the Jeju-Seoul route, flight time durations are either less than or equal to 70 minutes for even turboprop airplanes. Aircraft that use turboprop engines are suitable for short-haul flights with aircraft capacity ranging up to 100 passengers, but turboprop aircraft are considered unsafe among air passengers. Before the Deregulation Act of May 2008, non-scheduled air service carriers were only allowed to operate aircraft with less than 80 available seats per airplane. These restrictions on non-scheduled air service carriers greatly limited their aircraft availability and selection, and forced them to use small turbo-prop aircraft. Prior to deregulation most of the independent LCCs were non-scheduled air service carriers which were subject to this regulated market policy.

Tables 2-3 and 2-4 provide route-by-route summary statistics for Jeju routes and inland routes, respectively from two perspectives; pre and post deregulation. Data show how the characteristics in terms of fare level, monthly flight frequency, aircraft size, and airtime duration of full service legacy carriers and low cost carriers (LCCs) differ.[15]

goods only affect the size and significance level of airline carrier-specific fixed effects, and the relative size of the carrier-specific fixed effects does not change over the chosen percentages, 0.01% to 0.5%, of populations for origin cities. In our context, the welfare evaluation in chapter 6 will proceed with the chosen percentage (0.1%) of populations for origin cities.

[15]For each type of carriers (i.e. major, dependent LCCs, and independent LCCs), time varying market share weighted average values across different carriers within the same type are presented.

Table 2.3: Route-by-route descriptive statistics (average) for the Jeju island routes: pre- and post-deregulation (unbalanced panel, June 2006-October 2010)

Route	Carriers	Pre-deregulation (before May 2008)				Post-deregulation (after May 2008)			
		Fare (US $)	Flights	ACsize (# seats)	Duration (minutes)	Fare (US $)	Flights	ACsize (# seats)	Duration (minutes)
Jeju-Seoul	Major	70.25	1365	215	65	71.02	1340	216	65
	Dependent LCCs	NA				57.09	602	189	65
	Independent LCCs	53.19	504	76	82	61.25	476	135	70
Jeju-Busan	Major	54.22	446	193	55	59.09	393	201	55
	Dependent LCCs	NA				45.81	381	162	55
	Independent LCCs	40.18	183	78	60	52.88	137	119	59
Jeju-Cheongju	Major	61.66	230	176	60	62.57	230	186	60
	Dependent LCCs	NA				NA			
	Independent LCCs	52.26	194	72	68	52.25	150	114	63
Jeju-Daegu	Major	59.78	240	180	60	61.17	246	188	60
	Dependent LCCs	NA				NA			
	Independent LCCs	NA				63.63	48	109	65
Jeju-Gwangju	Major	50.21	249	177	45	56.67	234	180	45
	Dependent LCCs	NA				NA			
	Independent LCCs	NA				NA			

Table 2.4: Route-by-route descriptive statistics (average) for the inland routes: pre- and post-deregulation (unbalanced panel, June 2006-October 2010)

Route	Carriers	Pre-deregulation (before May 2008)				Post-deregulation (after May 2008)			
		Fare (US $)	Flights	Acsize (# seats)	Duration (minutes)	Fare (US $)	Flights	Acsize (# seats)	Duration (minutes)
Seoul-Busan	Major	62.21	881	170	55	72.15	751	171	55
	Dependent LCCs	NA				55.72	472	165	55
	Independent LCCs	48.82	129	78	55	NA			
Seoul-Gwangju	Major	54.94	233	174	50	61.41	209	173	50
	Dependent LCCs	NA				NA			
	Independent LCCs	NA				NA			

Before the Deregulation Act of May 2008, the two legacy carrier airlines, KAL and AAR, operated several jet aircraft including Boeing 737s and Airbus A330s. Unlike these two major airlines, the independent LCCs operated three turboprops (3 ATR72s, Hansung Air (HAN)) or four turboprops and two jet aircraft (4 Dash 8-Q400s and 2 Boeing 737s, Jeju Air (JJA)) while no dependent LCCs had emerged yet.

The most interesting feature here is the structural change of the Deregulation Act of May 2008. Of the four independent LCCs, two successfully have established their positions in domestic routes, while the other two, HAN and ONA, failed. In the post-deregulation period, even LCCs operated jet aircraft whose seat capacities exceeded 80 seats. These jet aircraft generally fly much faster than propeller-powered aircraft (turboprop aircraft with less than 80 seats), which enabled LCCs to carry more passengers, obtaining market competitiveness. For example, new independent LCC, Eastar Jet (ESR), launched its first flight from Jeju to Seoul with Boeing 737s on Jan 2009 and chose a single aircraft type fleet which allowed for greater efficiency in maintenance, following the low-cost structure pioneered by Southwest Airlines and EasyJet. ESR expanded its fleet up to six Boeing 737s in March 2010, increasing the daily flight frequency on some routes. The remaining independent LCC, JJA, was restructured by expanding capacities. JJA permanently removed all four Dash 8 Q400s, turboprop aircraft with 78 available seats per airplane, in June 2010. In 2011, continuing to consolidate around a single aircraft type, it added to capacity by purchasing another B737. It also plans to add three more B737s this year and another in 2013. HAN, however, ceased operations in Nov 2008 due to weak demand and budgetary constraints. Another independent LCC, ONA, launched in July 2008 with a single Fokker 100 (turboprop aircraft), ceased operations in December of the same year.

In response to these restructuring efforts of LCCs, the two legacy carriers, KAL and AAR, also launched their own subsidiary LCCs (dependent LCCs) in July 2008 (Jin Air (JNA) of KAL) and October 2008 (Air Busan (ABL) of AAR). ABL took its second delivery of a Boeing 737 in October 2008, and a third delivery of a Boeing 737 in November 2008.

As of July 2011, the ABL fleet consists of one Airbus A321 and six Boeing 737s. Another dependent LCC, JNA, began operations in July 2008 with four Boeing 737s from its parent company, KAL, seating 189 passengers of a single class.

As of July 2008, two months after the Deregulation Act of May 2008, the two major airlines, KAL and AAR started to impose airline specific fuel surcharges $14 on all domestic flights in response to rising oil and jet fuel prices. Prior to July 2008's announcement, fuel surcharges were only imposed on international routes. Airline specific fuel surcharges are re-assessed every two months, which are directly linked with Mean of Platts Singapore (MOPS), a measure of fuel oil pricing in Singapore.

In August 2008, the independent LCCs also imposed fuel surcharges, in the amounts of $13 (ONA), $10 (HAN), and $11 (JJA) on all flights. JNA, a wholly owned subsidiary LCC of KAL, imposed a fuel surcharge of $12.80 in September 2008, which was lower than the $16 of the two major airlines, but slightly higher than the $12.50 average of the independent LCCs' surcharges during the same time period. The dependent LCC, ABL, a partially owned subsidiary LCC of AAR, imposed a fuel surcharge of $11 in October 2008.

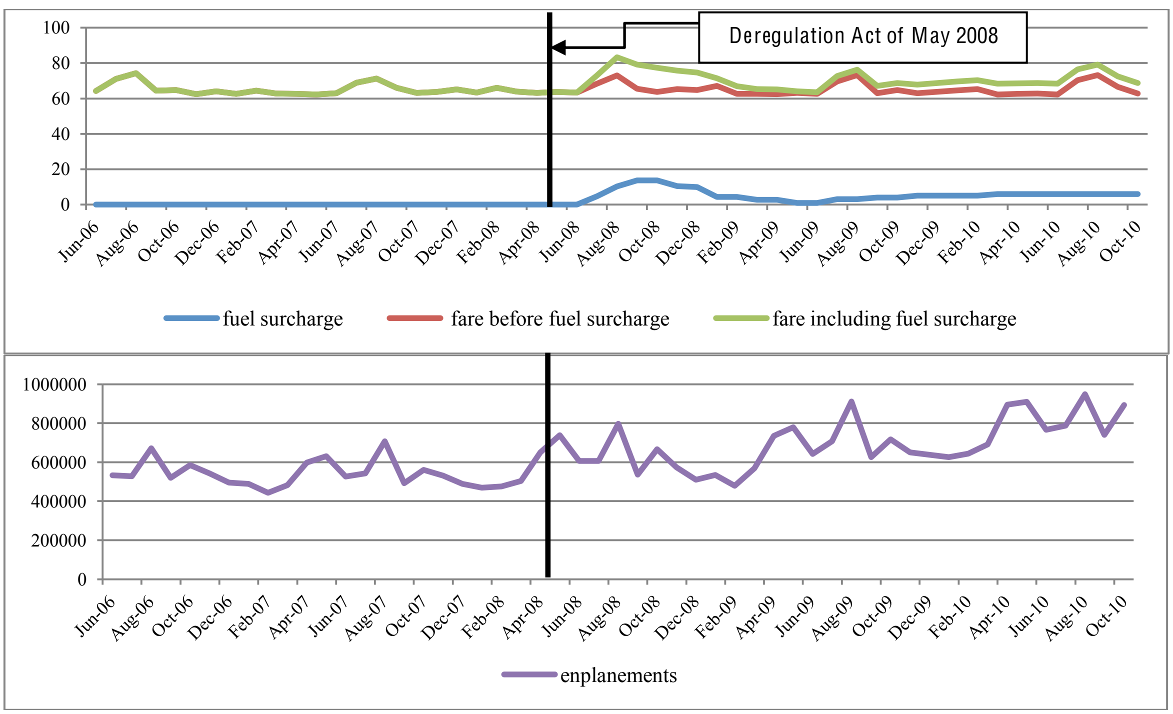
The introduction of fuel surcharges to offset rising fuel costs has had a negative impact on the pricing strategies of LCCs in the post-deregulation time period. Fare is a key competitive factor for LCCs because their success is based on providing air transport services to air passengers at lower fares. However, as shown in Tables 2-3 and 2-4, the route-wide average fares are higher in real terms than those from the pre-deregulation period in the Jeju-Seoul route and in the Seoul-Busan route. It is important to note that the fares of independent LCCs increased far more than those of the two rival major airlines on the Jeju-Seoul route and the Jeju-Busan route, the two largest domestic routes in Korea.

The consequences of implementing fuel surcharges on all domestic route flights had different impacts on Jeju island routes and inland routes. As shown in Figure 2.3,[16] no sub-

[16]Every route flying Jeju island shows a similar pattern.
See appendix Figure 3 (Jeju-Busan route), Figure 4 (Jeju-Cheongju route), Figure 5 (Jeju-Daegu route), and Figure 6 (Jeju-Gwangju route).

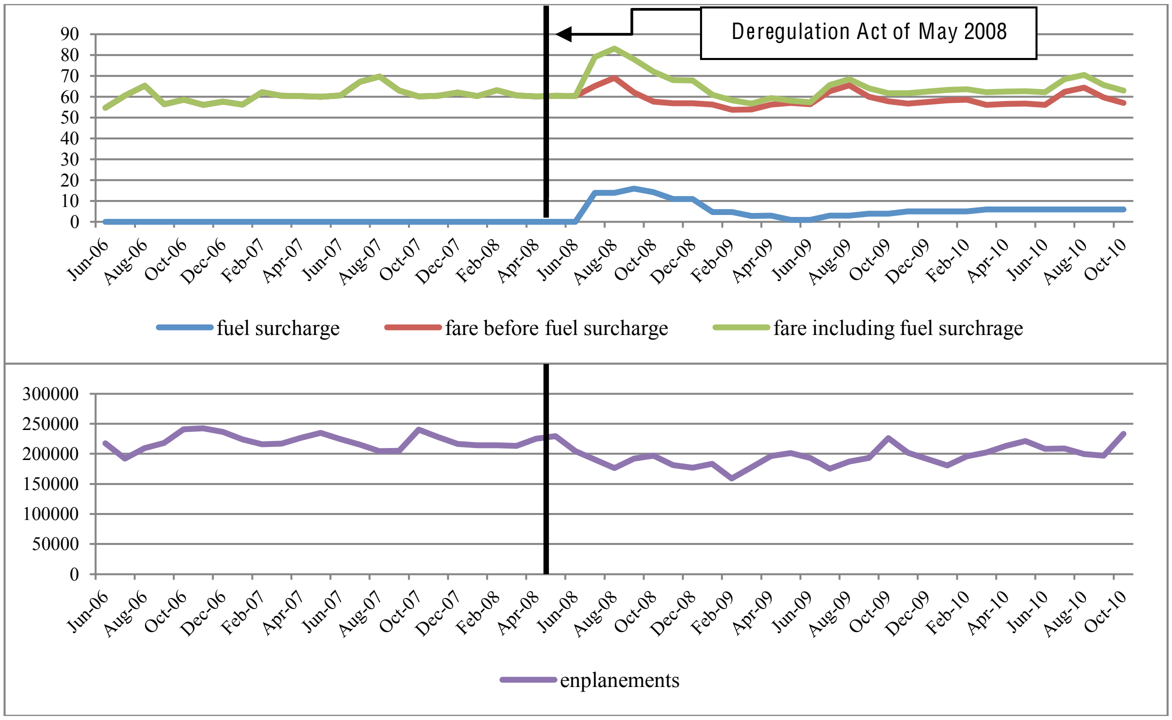
stantial drop in monthly enplanements on Jeju island routes is observed even at a time when all airline carriers, including the major airlines and LCCs, implemented fuel surcharges. In fact, there is an overall increasing tendency in enplanements on Jeju island routes during the sample period, from June 2006 to October 2010. By contrast, for the inland routes, a huge decrease in monthly enplanements is observed after airline carriers imposed high fuel surcharges (during July 2008 -January 2009) in Figure 2.4.[17]

Figure 2.3: Average monthly fares (in US $) and enplanements: Jeju-Seoul route



[17]See appendix Figure 7 (Seoul-Gwangju route).

Figure 2.4: Average monthly fares (in US $) and enplanements: Seoul-Busan route



2.4 Demand Results

The ideal instrumental variables in the nested logit demand are ones that shift costs but do not directly enter the demand equation (3) for Jeju routes or (6) for the inland routes. There are two different types of instruments: Berry, Levinsohn, and Pakes (BLP) style and Hausman panel style. Based on two sets of instruments, I present three different demand model specifications that only differ in the instruments. The BLP style instruments are used in column (i), the Hausman style instruments are used in column (ii), and the combined instruments of BLP and Hausman style are used in column (iii) specifications. The validity of the instruments along with robustness in point estimates requires comparing results from several sets of instrumental variables.

I provide route-by-route estimation results. For each route (five Jeju and two inland routes) there is a table showing results from each of the three different instrumental variables specification for that route. As in Bresnahan et al. [1997], the set of instruments in column (i), BLP style, are given by the observed exogenous characteristics, excluding fares from other airline carriers so that potentially endogenous regressors are not included; the count of airline carriers in the route; the mean of the observed exogenous characteristics of all the other airline carriers in the route; the mean of the observed exogenous characteristics of all the other flights on the other routes from the same airline carrier.[18] The second specification of the demand model uses Hausman style instruments in column (ii) and the set of instruments are given by the count of routes operated by the same airline carrier on the other Jeju island routes (the other inland routes); the mean of the fares from all the other Jeju island routes (the other inland routes) of the same airline carrier. The last specification of the demand model (column (iii)) uses the combined instruments of BLP and Hausman styles.

The three different demand model specifications are compared.[19] Some physical char-

[18]Alternative functions of the observed characteristics have been used as instruments but results do not qualitatively change.

[19]Cragg and Donald (1993) have proposed a test statistic that can be used to test for weak instruments. A test for weak identification-which means that the instruments are correlated with endogenous regressors, but

acteristics of flights such as airtime duration and aircraft size on some routes either didn't vary or only changed slightly over time. Thus, BLP style instruments are probably weak for routes with these characteristics in this context. The Hausman style instruments may also be questioned when there are national demand shocks.

2.4.1 Route by Route Estimates

Another consideration in air travel demand estimation is capacity constraints. Even if an airline carrier changes its fare, demand may not respond when a capacity limit has already been reached. For example, a change in fare would have no impact on total quantity demanded in a capacity constrained route and this would generate a downward bias in the fare coefficient estimates. To capture this effect, I estimate the demand model for all months excluding August (based on the average load factor, which is the percentage of seats occupied, August seems to face a capacity constraint problem), when demand is high relative to the number of flights or seat offered.[20] Results do not qualitatively change. The current demand model is robust to the capacity problem.

not highly correlated-is performed using Stata 11 and is interpreted using Stock and Yogo (2005).

[20] I limit this capacity constraint problem to the Jeju island routes only.

2.4.1.1 Jeju-Seoul Route (r = 1) ($\alpha_r > 0$)[21]

Table 2.5: Results with Nested Logit Demand Instrumental variable (IV) two-stage least squares (2SLS) regression: Jeju-Seoul route (r = 1)

Dependent variable, $ln(s_{jt}) - ln(s_{0t})$

1. Jeju-Seoul route (r = 1) Explanatory variable	(1) BLP	(2) Hausman	(3) Mix
Fare	0.144*** (0.041)	0.0572* (0.024)	0.0917*** (0.024)
$\ln(s_{jt/gt})$	0.775*** (0.064)	0.755*** (0.101)	0.730*** (0.077)
Flight frequency	0.481*** (0.139)	0.584** (0.211)	0.619*** (0.163)
Lunch ClusterDIFF	4.562*** (0.268)	3.931*** (0.201)	4.117*** (0.204)
Aircraft size	0.0639* (0.026)	0.045 (0.024)	0.0557* (0.025)
Airtime duration	-0.118*** (0.033)	-0.120** (0.045)	-0.130*** (0.039)
August (Peak)	0.322*** (0.045)	0.245*** (0.034)	0.267*** (0.035)
Semi-peak	0.0921*** (0.017)	0.0777*** (0.020)	0.0773*** (0.018)
Meteorological variable_snowfall	-0.0149*** (0.003)	-0.0149*** (0.004)	-0.0138*** (0.003)
GRDP per capita of Seoul	0.366** (0.125)	0.636*** (0.110)	0.571*** (0.112)
Constant	-0.790*** (0.223)	-1.266*** (0.198)	-1.149*** (0.205)
N observation	288	288	288
First stage partial R square: Fare	0.217	0.463	0.550
First stage partial R square: $\ln(s_{jt/gt})$	0.112	0.041	0.151

Robust standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

The coefficient on price enters with a negative sign in equation (3), meaning that a positive alpha ($\alpha_r > 0$) indicates a negatively sloped demand curve. The Jeju-Seoul route and the Jeju-Busan routes are the two largest domestic routes for LCCs. For the Jeju-Seoul route, most coefficients of product attributes are of the expected sign. The coefficients for fare

[21]The demand equation is $ln(s_{jt}) - ln(s_{0t}) = X^r_{Jeju,jt}\beta_r - \alpha_r p^r_{jt} + \gamma_r z_{it} + \sigma_r ln(s_{jt/gt}) + \xi_{jt}$ eq(3).

are statistically significant across all three specifications. The point estimates results suggest that greater choices for flights during a day and evenly scheduled flights during lunch hours increase the utility for the air travelers on the Jeju-Seoul route. Passengers would gain more utility from larger aircraft and shorter airtime duration. Strong seasonality effects are observed: higher demand in August and the semi-peak period. Year dummy variables and airline specific dummy variables are also included for controlling time-fixed effects and firm-fixed effects, respectively, but are not displayed in the table.

The first stage partial R^2 statistics for the fare variable are higher than those for the within group share variable, $ln\left(s_{jt/gt}\right)$. All three instruments are less effective in explaining the within group share variable, $ln\left(s_{jt/gt}\right)$. In particular, the BLP instruments are weaker in explaining the fare variable than either the Hausman instruments in column (ii) or the combined instruments of BLP and Hausman in column (iii). The key assumption for the BLP instruments is that observed characteristics are uncorrelated with the unobserved components. However, once a carrier specific dummy variable is included in order to control firm-specific fixed effects, a potential problem originates from this type instruments. Unless there is a variation in either the number of products offered in a market or product attributes, there is less variation in the BLP style instruments.[22]

[22]See Appendix Figure 8 for testing for weak instruments. According to test results, there is no strong evidence to reject any of the three null hypotheses, H_0 : The BLP type instruments are weak, H_0 : The Hausman type instruments are weak, and H_0 : A mix of both BLP type and Hausman type instruments is weak. The results on the primary coefficient of interest, Fare, are insensitive to the choice of instruments so despite the low first stage R^2 on $ln\left(s_{jt/gt}\right)$, the results look sufficiently reliable for our analysis, especially given that the Fare results for this route are similar to those for the other routes.

2.4.1.2 Jeju-Busan Route (r = 2) ($\alpha_r > 0$)[23]

Table 2.6: Results with Nested Logit Demand Instrumental variable (IV) two-stage least squares (2SLS) regression: Jeju-Busan route (r = 2)

Dependent variable, $ln(s_{jt}) - ln(s_{0t})$

2. Jeju-Busan route (r = 2) Explanatory variable	(1) BLP	(2) Hausman	(3) Mix
Fare	0.159** (0.049)	0.0982*** (0.025)	0.0824*** (0.025)
$\ln(s_{jt/gt})$	0.779*** (0.059)	0.966*** (0.119)	0.738*** (0.063)
Flight frequency	0.847*** (0.154)	0.344 (0.305)	0.901*** (0.158)
Lunch ClusterDIFF	1.713*** (0.477)	1.865*** (0.463)	1.939*** (0.462)
Aircraft size	0.125** (0.040)	0.068 (0.053)	0.155*** (0.040)
Airtime duration	-0.324*** (0.053)	-0.244*** (0.061)	-0.312*** (0.053)
August (Peak)	0.319*** (0.050)	0.310*** (0.047)	0.268*** (0.041)
Semi-peak	0.136*** (0.013)	0.149*** (0.015)	0.129*** (0.014)
Meteorological variable_snowfall	-0.0163*** (0.003)	-0.0204*** (0.004)	-0.0165*** (0.003)
GRDP per capita of Busan	-1.46 (0.859)	-2.119* (0.917)	-1.53 (0.795)
Constant	0.474 (0.363)	0.765* (0.383)	0.524 (0.333)
N observation	219	219	219
First stage partial R square: Fare	0.164	0.773	0.856
First stage partial R square: $\ln(s_{jt/gt})$	0.346	0.106	0.404

Robust standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

The coefficient on price enters with a negative sign in equation (3), meaning that a positive alpha ($\alpha_r > 0$) indicates a negatively sloped demand curve. For the Jeju-Busan route, most coefficients of flight attributes are of the expected sign, but the coefficients for flight frequency and aircraft size are not significant under the second specification using the Hausman type instruments. One possible explanation for this insignificance is due to low first stage

[23]The demand equation is $ln(s_{jt}) - ln(s_{0t}) = X^r_{Jeju,jt}\beta_r - \alpha_r p^r_{jt} + \gamma_r z_{it} + \sigma_r ln\left(s_{jt/gt}\right) + \xi_{jt}$ eq(3).

fit for the within group share variable $ln\left(s_{jt/gt}\right)$. In the presence of weak instruments, this endogenous variable remains significant at the 5% level with a much greater point estimate (0.966) than in the other two columns. This estimate may be associated with measurement error in the first stage correlation with some of the airline characteristics. In common with the Jeju-Seoul route, evenly scheduled flights over lunchtime would provide more utility on the Jeju-Busan route. August dummy and semi-peak dummy are positive and also significant. Year dummy variables and airline specific dummy variables are also included for controlling time-fixed effects and firm-fixed effects, respectively, but not displayed in the table.

In a rough way, the BLP type instruments in column (i) tend to explain the within group share variable $ln\left(s_{jt/gt}\right)$ well while the Hausman type instruments are strong in explaining the fare variable in column (ii).[24]

[24] See Appendix Figure 8 for testing for weak instruments. Testing for weak instruments led to rejecting the null hypothesis, H_0 : A mix of both BLP type and Hausman type instruments is weak. There is no statistical evidence to reject the null hypotheses, H_0 : The BLP type instruments are weak and H_0 : The Hausman type instruments are weak.

2.4.1.3 Jeju-Cheongju Route (r = 3) $(\alpha_r > 0)$[25]

Table 2.7: Results with Nested Logit Demand Instrumental variable (IV) two-stage least squares (2SLS) regression: Jeju-Cheongju route (r = 3)

Dependent variable, $ln(s_{jt}) - ln(s_{0t})$

3. Jeju-Cheongju route (r = 3) Explanatory variable	(1) BLP	(2) Hausman	(3) Mix
Fare	0.158*** (0.039)	0.0677** (0.023)	0.0748*** (0.021)
$\ln(s_{jt/gt})$	0.508*** (0.097)	0.357*** (0.105)	0.475*** (0.077)
Flight frequency	2.730*** (0.595)	3.668*** (0.770)	3.121*** (0.613)
Lunch ClusterDIFF	-0.0726* (0.031)	-0.0543 (0.033)	-0.0585 (0.031)
Aircraft size	0.406*** (0.066)	0.539*** (0.081)	0.467*** (0.067)
Airtime duration	0.010 (0.022)	0.012 (0.024)	0.013 (0.022)
August (Peak)	0.288*** (0.043)	0.209*** (0.034)	0.220*** (0.034)
Semi-peak	0.0960*** (0.013)	0.0821*** (0.014)	0.0856*** (0.014)
Meteorological variable_snowfall	-0.00242 (0.003)	-0.0000447 (0.003)	-0.00078 (0.003)
GRDP per capita of Cheongju	2.264 (1.675)	4.443* (1.812)	4.237* (1.692)
Constant	-0.246 (0.127)	-0.387** (0.138)	-0.381** (0.129)
N observation	229	229	229
First stage partial R square: Fare	0.288	0.930	0.970
First stage partial R square: $\ln(s_{jt/gt})$	0.510	0.297	0.518

Robust standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

The coefficient on price enters with a negative sign in equation (3), meaning that a positive alpha $(\alpha_r > 0)$ indicates a negatively sloped demand curve. For the Jeju-Cheongju route, most coefficients of product attributes are of the expected sign. Greater choices of flight frequency during a day and larger aircraft would provide higher utility for air travelers. And, although the positive coefficients on airtime duration in all columns are not of

[25] The demand equation is $ln(s_{jt}) - ln(s_{0t}) = X^r_{Jeju,jt}\beta_r - \alpha_r p^r_{jt} + \gamma_r z_{it} + \sigma_r ln\left(s_{jt/gt}\right) + \xi_{jt}$ eq(3).

expected sign, these are statistically insignificant. One possible explanation for this insignificance is due to small variation for the airtime duration variable across airline carriers. The impacts of the lunch $ClusterDIFF$ variable on passengers' utilities are all negative across columns $(i)-(iii)$ and only statistically significant under the column (i) specification using the BLP type instruments. Thus, the point estimates results would not support the *prediction* Departure flight schedules around lunchtime (10AM-4PM) are more evenly distributed in the Jeju island routes than in the inland routes. As vacationers' most preferred departure times are concentrated into lunchtime, I expected to find the positive coefficient on the lunch $ClusterDIFF$. Strong seasonality effects are also observed on the Jeju-Cheongju route. Year dummy variables and airline specific dummy variables are also included for controlling time-fixed effects and firm-fixed effects, respectively, but not displayed in the table.

With regard to the first stage partial R^2 statistics for two endogenous variables, fare p^r_{jt} and within group share $ln\left(s_{jt/gt}\right)$, the BLP type instruments in column (i) tend to explain the within group share variable well while the Hausman type instruments are strong in explaining the fare variable in column (ii).[26]

[26]See Appendix Figure 8 for testing for weak instruments. Testing for weak instruments led to rejecting each of three null hypotheses, H_0 : The BLP type instruments are weak, H_0 : The Hausman type instruments are weak, and H_0 : A mix of both BLP type and Hausman type instruments is weak.

2.4.1.4 Jeju-Daegu Route (r = 4) $(\alpha_r > 0)$[27]

Table 2.8: Results with Nested Logit Demand Instrumental variable (IV) two-stage least squares (2SLS) regression: Jeju-Daegu route (r = 4)

Dependent variable, $ln(s_{jt}) - ln(s_{0t})$

4. Jeju-Daegu route (r = 4) Explanatory variable	(1) BLP	(2) Hausman	(3) Mix
Fare	0.0808** (0.025)	0.0960*** (0.023)	0.0968*** (0.023)
$\ln(s_{jt/gt})$	1.036*** (0.261)	0.934*** (0.140)	0.843*** (0.185)
Flight frequency	3.166* (1.249)	3.594*** (0.807)	3.916*** (0.787)
Lunch ClusterDIFF	0.246*** (0.045)	0.237*** (0.039)	0.232*** (0.040)
Aircraft size	0.917*** (0.208)	0.891*** (0.199)	0.889*** (0.197)
August (Peak)	0.219*** (0.036)	0.226*** (0.037)	0.225*** (0.038)
Semi-peak	0.0979*** (0.016)	0.0954*** (0.014)	0.0926*** (0.014)
Meteorological variable_snowfall	-0.00930*** (0.002)	-0.00922*** (0.002)	-0.00918*** (0.002)
GRDP per capita of Daegu	0.681 (0.731)	0.617 (0.696)	0.687 (0.707)
Constant	-0.215 (0.179)	-0.2 (0.171)	-0.216 (0.174)
N observation	161	161	161
First stage partial R square: Fare	0.494	0.973	0.983
First stage partial R square: $\ln(s_{jt/gt})$	0.042	0.092	0.104

Robust standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

The coefficient on price enters with a negative sign in equation (3), meaning that a positive alpha $(\alpha_r > 0)$ indicates a negatively sloped demand curve. For the Jeju-Daegu route, airtime duration variable cannot be included in the estimation equation because there is no variation in the airtime duration across airline carriers. Most coefficients of flight attributes are of the expected sign in the column (ii) and (iii) specifications, but not in the column (i) specification using only the BLP style instruments. In particular, the nesting parameter σ_r

[27] The demand equation is $ln(s_{jt}) - ln(s_{0t}) = X^r_{Jeju,jt}\beta_r - \alpha_r p^r_{jt} + \gamma_r z_{it} + \sigma_r ln\left(s_{jt/gt}\right) + \xi_{jt}$ eq(3).

is estimated to be larger than 1 (1.036). Note that this estimate should satisfy the necessary restriction for the nested logit model to be consistent with utility maximization: significantly less than 1 and greater than 0, that is, there is a segmentation between the inside good, $g = 1$ air travel choice, and the outside good, $g = 0$. Thus, the specification using only the BLP style instruments (column (i)) is not consistent with random utility maximization theory. At the same time that the estimate forσ_r is outside of the reasonable zone bounded above by 1, it remains significant at the 5% level.

Passengers would gain more utility from greater choices of flights during a day and evenly scheduled flights around lunch hour. Larger aircraft would provide higher utility for passengers. Strong seasonality effects are also observed on the Jeju-Daegu route. Year dummy variables and airline specific dummy variables are also included for controlling time-fixed effects and firm-fixed effects, respectively, but not displayed in the table. All three type instruments are less effective in explaining the within group share variable, $ln\left(s_{jt/gt}\right)$ because $s_{jt/gt}$ would potentially drop out with airline fixed effects.[28]

[28] See Appendix Figure 8 for testing for weak instruments. There is no strong evidence to reject any of the three null hypotheses, H_0 : The BLP type instruments are weak, H_0 : The Hausman type instruments are weak, and H_0 : A mix of both BLP type and Hausman type instruments is weak. One need not examine this more closely because the primary coefficient of interest, on Fare, is insensitive to the choice of instruments.

2.4.1.5 Jeju-Gwangju Route (r = 5) ($\alpha_r > 0$)[29]

Table 2.9: Results with Nested Logit Demand Instrumental variable (IV) two-stage least squares (2SLS) regression: Jeju-Gwangju route (r = 5)

Dependent variable, $ln(s_{jt}) - ln(s_{0t})$

5. Jeju-Gwangju route (r = 5) Explanatory variable	(1) BLP	(2) Hausman	(3) Mix
Fare	0.0940* (0.038)	0.0658** (0.023)	0.0704** (0.022)
$ln(s_{jt/gt})$	0.438** (0.150)	0.884** (0.317)	0.419** (0.151)
Flight frequency	3.769*** (0.612)	2.566** (0.933)	3.844*** (0.609)
Lunch ClusterDIFF	-0.106 (0.113)	-0.0509 (0.130)	-0.131 (0.116)
Aircraft size	-0.245 (0.236)	-0.407 (0.280)	-0.226 (0.236)
August (Peak)	0.150*** (0.033)	0.146*** (0.030)	0.138*** (0.028)
Semi-peak	0.0677*** (0.013)	0.0725*** (0.013)	0.0660*** (0.013)
Meteorological variable_snowfall	-0.00742*** (0.002)	-0.00773*** (0.002)	-0.00739*** (0.002)
GRDP per capita of Gwangju	-0.556 (1.225)	-0.455 (1.149)	-0.127 (1.165)
Constant	0.0221 (0.198)	0.0101 (0.187)	-0.0445 (0.190)
N observation	156	156	156
First stage partial R square: Fare	0.346	0.959	0.975
First stage partial R square: $ln(s_{jt/gt})$	0.754	0.216	0.766

Robust standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

The coefficient on price enters with a negative sign in equation (3), meaning that a positive alpha ($\alpha_r > 0$) indicates a negatively sloped demand curve. For the Jeju-Gwangju route, where no entrant was observed, the airtime duration variable could not be included in the estimation equation given that this route has only been operated by the two major airlines, Korean Air (KAL) and Asiana Airlines (AAR), creating no variation in airtime duration across airline carriers. The negative coefficients for aircraft size are not of expected

[29] The demand equation is $ln(s_{jt}) - ln(s_{0t}) = X^r_{Jeju,jt}\beta_r - \alpha_r p^r_{jt} + \gamma_r z_{it} + \sigma_r ln\left(s_{jt/gt}\right) + \xi_{jt}$ eq(3).

sign, but are not significant across all three specifications. Passengers would gain utility from greater choices of flights during a day. The coefficients on the lunch $ClusterDIFF$ are neither positive nor statistically significant. The point estimates results for the lunch $ClusterDIFF$ variable would not support the *prediction* Departure flight schedules around lunchtime (10AM-4PM) are more evenly distributed in the Jeju island routes than in the inland routes. As vacationers' most preferred departure times are concentrated into lunchtime, I expected to find the positive coefficient on the lunch $ClusterDIFF$. Year dummy variables and airline specific dummy variables are also included for controlling for time-fixed effects and firm-fixed effects, respectively, but are not displayed in the table.

In a rough way, the BLP type instruments in column (i) tend to explain the within group share variable well while the Hausman type instruments are strong in explaining the fare variable in column (ii).[30]

[30] See Appendix Figure 8 for testing for weak instruments. Testing for weak instruments led to rejecting each of three null hypotheses, H_0 : The BLP type instruments are weak, H_0 : The Hausman type instruments are weak, and H_0 : A mix of both BLP type and Hausman type instruments is weak.

2.4.1.6 Seoul-Busan Route (r = 6) $(\alpha_r > 0)$[31]

Table 2.10: Results with Nested Logit Demand Instrumental variables (IV) two-stage least squares (2SLS) regression: Seoul-Busan route (r = 6)

Dependent variable, $ln(s_{jt}) - ln(s_{0t})$

6. Seoul-Busan route (r = 6) Explanatory variable	(1) BLP	(2) Hausman	(3) Mix
Fare	0.0627* (0.028)	0.0816*** (0.015)	0.0884*** (0.015)
$\ln(s_{jt/gt})$	0.989*** (0.033)	0.869*** (0.090)	0.873*** (0.075)
Flight frequency	0.052 (0.071)	0.263 (0.147)	0.255* (0.122)
Lunch ClusterDIFF	8.979*** (2.463)	9.737*** (2.452)	9.634*** (2.502)
Aircraft size	-0.161 (0.127)	-0.0696 (0.180)	-0.0767 (0.169)
August (Peak)	0.012 (0.019)	0.0321* (0.016)	0.0354* (0.017)
Semi-peak	0.0261** (0.010)	0.0264** (0.010)	0.0272** (0.010)
GRDP per capita of Busan	-0.516 (0.505)	-0.357 (0.516)	-0.453 (0.444)
Constant	0.238 (0.206)	0.164 (0.214)	0.202 (0.183)
N observation	168	168	168
First stage partial R square: Fare	0.175	0.773	0.796
First stage partial R square: $\ln(s_{jt/gt})$	0.327	0.063	0.379

Robust standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

The coefficient on price enters with a negative sign in equation (6), meaning that a positive alpha $(\alpha_r > 0)$ indicates a negatively sloped demand curve. For the Seoul-Busan route, the largest inland route for LCCs, the airtime duration variable cannot be included in the estimation equation because there is no variation in airtime duration across airline carriers. One possible explanation is that there are special differences between very short-haul routes and routes which are longer-haul (in fact it only takes less than 60 minutes for most of the

[31] The demand equation is $ln(s_{jt}) - ln(s_{0t}) = X^r_{Inland,jt}\beta_r - \alpha_r p^r_{jt} + \gamma_r z_{it} + \sigma_r ln\left(s_{jt/gt}\right) + \xi_{jt}$, eq(6).

inland routes). The coefficients for flight frequency are insignificant under the first two specifications, but are of expected sign. The coefficients for aircraft size are not significant across all three specifications. The positive impacts of the lunch $ClusterDIFF$ on consumers' utilities are not expected since the inland routes are primarily for business travelers with a less strong preference for evenly scheduled flights at lunchtime than for the Jeju island routes.The point estimates results imply that evenly distributed flights over lunch hours would provide higher utility for passengers due to greater choices of departure flight times. In this context, the estimation results on the Seoul-Busan route would not support the *prediction* Departure flight schedules around lunchtime (10AM-4PM) are more evenly distributed in the Jeju island routes than in the inland routes. The August dummy effect are relatively weak when compared with the Jeju island routes. This is not surprising given that business travel is less likely to be seasonal than vacation travel.

The BLP type instruments are weak in explaining the fare variable. In fact most physical flight characteristics, i.e., aircraft type and airtime duration, are constant over time, thus would be probably weak in this context. Possibly as a consequence of weak instruments, the fare variable is less significant in the final stage (at the 5% significance level of the test) whereas it is highly significant in the other two specifications. This finding is consistent with the expected positive correlation between fares and unobserved flight quality that would generate a downward bias in the fare coefficient estimate in column (i). On the other hand, the Hausman type instruments are weakly correlated endogenous regressor, the within group share variable, $ln\left(s_{jt/gt}\right)$, having a poor fit of the first stage partial R^2, 0.063. In the presence of weak instruments, this endogenous variable remains significant at the 5% level of the test.[32]

[32]See Appendix for testing for weak instruments. According to testing for weak instruments, there is no strong evidence to reject any of the three null hypotheses, H_0 : The BLP type instruments are weak, H_0 : The Hausman type instruments are weak, and H_0 : A mix of both BLP type and Hausman type instruments is weak. The results on the primary coefficient of interest, Fare, are insensitive to the choice of instruments and are similar to the Fare coefficient in the other inland route and the five Jeju island routes. So despite not being able to reject the weak instruments null hypotheses, the result look reasonable for our analysis.

2.4.1.7 Seoul-Gwangju Route (r = 7) ($\alpha_r > 0$)[33]

Table 2.11: Results with Nested Logit Demand Instrumental variables (IV) two-stage least squares (2SLS) regression: Seoul-Gwangju route (r = 7)

Dependent variable, $ln(s_{jt}) - ln(s_{0t})$

7. Seoul-Gwangju route (r = 7) Explanatory variable	(1) BLP	(2) Hausman	(3) Mix
Fare	0.033 (0.111)	0.0892*** (0.018)	0.0823*** (0.016)
$\ln(s_{jt/gt})$	0.488** (0.188)	0.527* (0.214)	0.654*** (0.144)
Flight frequency	4.089*** (1.215)	4.068*** (1.061)	3.457*** (0.785)
Lunch ClusterDIFF	0.295** (0.099)	0.309*** (0.071)	0.291*** (0.068)
Aircraft size	2.793 (1.797)	3.782 (2.369)	5.021** (1.744)
August (Peak)	-0.0479 (0.046)	-0.0207 (0.014)	-0.0181 (0.013)
Semi-peak	-0.00341 (0.011)	-0.000143 (0.010)	0.00173 (0.010)
GRDP per capita of Gwangju	-1.36 (2.455)	-2.608*** (0.712)	-2.510*** (0.699)
Constant	0.255 (0.385)	0.449*** (0.119)	0.433*** (0.117)
N observation	156	156	156
First stage partial R square: Fare	0.022	0.821	0.876
First stage partial R square: $\ln(s_{jt/gt})$	0.217	0.181	0.251

Robust standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

The coefficient on price enters with a negative sign in equation (6), meaning that a positive alpha ($\alpha_r > 0$) indicates a negatively sloped demand curve. For the Seoul-Gwangju route, where only the two major airlines fly, the airtime duration variable could not be included in the estimation equation because there is no variation in airtime duration across airline carriers. Most coefficients of flight attributes are of the expected sign. Under the BLP type instruments in column (i) Fare, an endogenous variable, is statistically insignificant with a much lower point estimate (0.033) than in the other two columns. The BLP type

[33]The demand equation is $ln(s_{jt}) - ln(s_{0t}) = X^r_{Inland,jt}\beta_r - \alpha_r p^r_{jt} + \gamma_r z_{it} + \sigma_r ln\left(s_{jt/gt}\right) + \xi_{jt}$, eq(6).

instruments are very weak in explaining the Fare variable, p^r_{jt}, specifically the first stage R^2 for the Fare variable has a poor fit of only 0.022. In the presence of weak instruments, carrier specific unobserved quality or brand reputation could be possibly correlated to prices, causing the point estimate to drop. Possibly as a consequence of the poor first stage fit, the Fare variable is not significant in the second stage estimation.

In a similar way in the Seoul-Busan route, the positive impacts of the lunch $ClusterDIFF$ on consumers' utilities are not expected since the inland routes are primarily for business travelers with a less strong preference for evenly scheduled flights at lunchtime than for the Jeju island routes. The point estimates results the lunch $ClusterDIFF$ imply that evenly distributed flights over lunch hours would provide higher utility for passengers due to greater choices of departure flight times. In this context, the estimation results on the Seoul-Busan route would not support the *prediction* Departure flight schedules around lunchtime (10AM-4PM) are more evenly distributed in the Jeju island routes than in the inland routes. The August dummy and semi-peak dummy variable capture the effects of seasonality in air travel demand. The effects are statistically insignificant, but this is not surprising given that business travel is less likely to be seasonal than vacation travel. In a rough way, the BLP type instruments in column(i) tend to explain the within group share variable well while the Hausman type instruments are strong in explaining the fare variable in column(ii).[34]

In summarizing the route-by-route demand estimation results, three different specifications are compared. First, the primary coefficient of interest, Fare, are insensitive to the choice of instruments for the Jeju island routes. One can reject the hypothesis that instruments are weak in the first stage estimation for at least one column in the demand estimation results tables of the three routes: Jeju-Busan (r = 2), Jeju-Cheongju (r = 3), and Jeju-Gwangju (r = 5). It would imply that we can reject weak instruments may be generating undesirable

[34]See Appendix Figure 8 for testing for weak instruments. Testing for weak instruments led to rejecting the null hypotheses, H_0 : The Hausman type instruments are weak and H_0 : A mix of both BLP type and Hausman type instruments is weak. There is no statistical evidence to reject the null hypothesis H_0 : The BLP type instruments are weak. One need not examine this more closely because coefficient results on fare are robust.

biases in point estimation results for these three routes. Given that the Fare results for other two Jeju island routes (Jeju-Seoul (r = 1) and Jeju-Daegu (r = 4)) are robust within each of these two routes, and are similar to those of other three Jeju island routes mentioned earlier, the Jeju island air travel demand estimation results look reliable for our analysis. The BLP type instruments - the observed exogenous flight characteristics, excluding fares, from other airline carriers within each route - are effective in explaining the within group share variable in the first stage estimation. On the other hand, the Hausman type instruments are more effective in explaining the Fare variable in the first stage estimation in that the prices in other Jeju island routes of the same airline carrier are used as the instruments.

Second, for the inland routes, the estimates results on Fare are less robust on the Seoul-Gwangju route (r = 7). In the presence of weak instruments, the point estimate under the BLP type instruments is insignificant at 5% significance level. Less variation in flight attributes, i.e., the airtime duration variable has no variation across carriers, would result in less variation in the BLP type instruments. One can reject the hypothesis that instruments are weak in the first stage estimation for at least one column in the demand estimation results tables of the Seoul-Busan route (r = 6). Since the coefficient on the fare variable, our primary focus, is mostly robust, we proceed using these estimates. Like the Jeju island routes, the BLP type instruments are effective in explaining the within group share variable in the first stage estimation while the Hausman type instruments are effective in explaining the Fare variable in the first stage estimation.

Indeed for most flight characteristics variables the other coefficients are robust across all 7 routes including five Jeju island routes and two inland routes. These are estimated to have expected effects. Frequent flights, shorter airtime duration, and larger aircraft would provide higher utility for air travelers. But, evenly scheduled flights over lunchtime are estimated to have route-specific effects across all 7 routes. Strong seasonality is observed on the Jeju island routes while weak seasonality is observed on the inland routes.

2.4.2 Do Routes Look Similar

2.4.2.1 Jeju Island Routes

Table 2.12 provides the main parameters of interest for the Jeju island routes $r = 1,2,3,4,5$, α_r and σ_r, which determine the estimated price elasticities and price cost markups. Note that these estimates using the Hausman type instruments (column (ii) in Tables 2.5, 2.6, 2.7, 2.8, and 2.9 for each of the five Jeju island routes) satisfy the necessary restrictions for the nested logit model to be consistent with utility maximization. Air passengers respond to a price increase by reducing demand ($\alpha_r > 0\ \forall r = 1,2,3,4,5$).[35] Since the nesting parameter σ_r, the parameter of within group share variable $ln\left(s_{jt/gt}\right)$, is less than 1 and significantly greater than 0 for all five Jeju island routes,[36] there is a segmentation between the "inside good" group, $g = 1$, and the "outside good" group, $g = 0$.

Table 2.12: Estimates of main parameters of interest $(\alpha_r > 0)$ for the Jeju island routes $r = 1,2,3,4,5$ from the demand specification using the Hausman type instruments only

Explanatory variable	Parameter	Jeju island route				
		Jeju-Seoul	Jeju-Busan	Jeju-Cheongju	Jeju-Daegu	Jeju-Gwangju
Fare	α_r	0.0572*	0.0982***	0.0904***	0.096***	0.0658**
		(0.024)	(0.025)	(0.024)	(0.023)	(0.023)
$\ln(s_{jt/gt})$	σ_r	0.755***	0.966***	0.303*	0.934***	0.884**
		(0.101)	(0.119)	(0.119)	(0.140)	(0.317)
# of entrants	Dependent LCCs	JNA	ABL,JNA	None	None	None
	Independent LCCS	HAN,ONA,ESR,TWB	JJA,ONA,	JJA, ESR	ONA	None

Robust standard errors are in round parenthesis; Significance levels are *5%,**1%,***0.1%.

First, if there are *a priori* expectations of no differences in terms of demand sensitivity to price within the Jeju island routes, I would expect the fare coefficient α to be the same across

[35]The coefficient on price enters with a negative sign in equation (6), meaning that a positive alpha $(\alpha_r > 0)$ indicates a negatively sloped demand curve.

[36]The null hypothesis that $\sigma_r = 1$ is tested for each of the Jeju island routes. One can reject the null hypothesis for the Jeju-Seoul route and the Jeju-Cheongju route respectively at 5% significance level. One can reject the null hypothesis for the Jeju-Busan route at 15% significance level. However, there is no statistical evidence to reject the null hypothesis for the Jeju-Daegu route or the Jeju-Gwangju route.

the Jeju island routes. The Wald test, *a posteriori* contrast analysis, for the joint equality for the fare coefficients is used to test the null hypothesis, $H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5$, a common sensitivity to price, $\alpha_{Jeju} = \alpha_r, \forall r = 1,2,3,4,5$ for the Jeju island routes in eq(3).[37]

1. Fare coefficient

$Chi^2(4) = 2.56$

$Prob > Chi^2 = 0.6334$

The Chi^2 value generated by the Wald test along with the associated p-value indicates that there is no statistical evidence to reject the null hypothesis. Thus, I may assume a common fare coefficient within the Jeju island routes,$\alpha_{Jeju} = \alpha_r, \forall r = 1,2,3,4,5$.

Second, if there are *a priori* expectations of different air travel demand sensitivities to flight characteristics, such as flight frequency, aircraft size, and airtime duration within the Jeju island routes, I would expect the flight characteristics to have different effects for different routes. The Wald tests for the joint equality for each flight characteristic coefficient across the Jeju island routes, $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$, are also tested, separately.[38]

2. Flight frequency

$Chi^2(4) = 108.48$

$Prob > Chi^2 = 0.000$

3. Aircraft size

$Chi^2(4) = 524.13$

[37] The Wald test is performed using Stata 11's **test command**.

[38] The Wald test is performed using Stata 11's **test command**. Similarly, the null hypothesis $H_0 : \sigma_1 = \sigma_2 = \sigma_3 = \sigma_4 = \sigma_5$ is tested. The Wald test can reject the null, implying that there are route-specific nesting parameters.

$Prob > Chi^2 = 0.000$

4. Airtime duration

$Chi^2(4) = 56.45$

$Prob > Chi^2 = 0.000$

5. Lunch $ClusterDIFF$

$Chi^2(4) = 1199.08$

$Prob > Chi^2 = 0.000$

The Wald test can reject the null hypothesis, implying that air travelers respond to flight frequency, aircraft size, and airtime duration in different ways across the Jeju routes. Thus, the flight characteristics should be permitted to have route-specific effects. In addition, lunch cluster flights have different effects on the routes, i.e., the benefits from evenly distributed departure flights during lunchtime differ across the Jeju island routes.

Specifically, the joint equality tests for the coefficients for the month of August and for the semi-peak months dummy variables across the Jeju island routes, $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5$, are conducted, separately.

6. Seasonality effect: August month

$Chi^2(4) = 17.12$

$Prob > Chi^2 = 0.0018$

7. Seasonality effect: Semi-peak months

$Chi^2(4) = 9.95$

$Prob > Chi^2 = 0.0413$

The route specific effects are also found in the August month and semi-peak months dummy variables (seasonality effects).

2.4.2.2 Inland Routes

Table 2.13 provides the main parameters of interest for the inland routes $r = 6, 7$, α_r and σ_r, which determine the estimated price elasticities and price cost markups. Note that these estimates using the Hausman type instruments (column (ii) in Tables 2.10 and 2.11 for each of the two inland routes) satisfy the necessary restrictions for the nested logit model to be consistent with utility maximization. Since the nesting parameter σ_r, the parameter for the within group share variable $ln\left(s_{jt/gt}\right)$, is less than 1 and significantly greater than 0,[39] there is a segmentation between the "inside good" group, $g = 1$, and the "outside good" group, $g = 0$.

Table 2.13: Estimates of main parameters of interest (α_r) for the inland routes $r = 6, 7$ from the demand specification using the Hausman type instruments only

Explanatory variable	Parameter	Inland route	
		Seoul-Busan	Seoul-Gwangju
Fare	α_r	0.0816*** (0.015)	0.0892*** (0.018)
$\ln(s_{jt/gt})$	σ_r	0.869*** (0.090)	0.527* (0.214)
# of entrants	Dependent LCCs	ABL, JNA	None
	Independent LCCS	None	None

Robust standard errors are in round parenthesis; Significance levels are *5%,**1%,***0.1%.

First, if there are *a priori* expectations of no differences in terms of demand sensitivity to price within the inland routes, I would expect the fare coefficient α to be the same across the inland routes. The Wald test, *a posteriori* contrast analysis for the joint equality for the

[39]The null hypothesis that $\sigma_r = 1$ is tested for each of the inland routes. One can reject the null hypothesis for the Seoul-Gwangju route at 5% significance level. One can reject the null hypothesis for the Seoul-Busan route at 15% significance level.

fare coefficients is used to test the null hypothesis, $H_0 : \alpha_6 = \alpha_7$, a common sensitivity to price,$\alpha_{Inland} = \alpha_r, \forall r = 6,7$ for the inland routes in eq(6).[40]

1. Fare coefficient

$Chi^2(1) = 2.37$

$Prob > Chi^2 = 0.1236$

The Chi^2 value generated by the Wald test along with the associated p-value indicates that there is no statistical evidence to reject the null hypothesis. Thus, I may assume a common fare coefficient $\alpha_{Inland} = \alpha_r, \forall r = 6,7$ for the inland routes.

Second, if there are *a priori* expectations of different air travel demand sensitivities to flight characteristics, such as flight frequency, aircraft size, and airtime duration within the inland routes, I would expect the flight characteristics to have different effects for different routes. The Wald tests for the joint equality for each flight characteristic across the inland routes, $H_0 : \beta_6 = \beta_7$, are also tested, separately.[41]

2. Flight frequency

$Chi^2(1) = 18.77$

$Prob > Chi^2 = 0.000$

3. Aircraft size

$Chi^2(1) = 0.72$

$Prob > Chi^2 = 0.3976$

[40] The Wald test is performed using Stata 11's **test command**.

[41] The Wald test is performed using Stata 11's **test command**. Similarly, the null hypothesis $H_0 : \sigma_6 = \sigma_7$ is tested. The Wald test can reject the null, implying that there are route-specific nesting parameters.

4. Airtime duration[42]

5. Lunch $ClusterDIFF$

$Chi^2(1) = 11.33$

$Prob > Chi^2 = 0.0008$

The Wald test can reject the null hypothesis, implying that air travelers respond to flight frequency in different ways across the inland routes, but have common sensitivity with respect to air craft size. The two inland routes have route-specific lunch cluster flights effects.

In addition, the joint equality tests for the coefficients for the month of August and for the semi-peak months dummy variables across the inland routes, $H_0 : \beta_6 = \beta_7$, are conducted, separately.

6. Seasonality effect: August month

$Chi^2(1) = 2.24$

$Prob > Chi^2 = 0.1347$

7. Seasonality effect: Semi-peak months

$Chi^2(1) = 4.06$

$Prob > Chi^2 = 0.0439$

Inland travelers respond to August in the same way, but the route specific effects are found in the semi-peak months dummy variables (seasonality effects).

[42]For the inland routes, airtime duration variables are time invariant given a route. So the variable is dropped.

2.4.2.3 Joint Constraint for All Routes, $\forall r = 1,2,3,4,5,6,7$, Jeju Island and Inland Routes

The Jeju island routes and the inland routes have different alternative transportation modes and types of travelers. For the inland routes, alternatives include bus, rail, and automobile transportation. To get to Jeju island, however, the ferry is really not a viable option. And with respect to types of travelers, the Jeju island routes are primarily for vacation travelers, and the inland routes attract a greater number of business travelers.

Even though there are *a priori* expectations of different air travel demand sensitivity to price between the Jeju island routes and the inland routes, the joint equality test for the fare coefficients across the Jeju island routes and the inland routes, $H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 \, (\alpha_{Jeju} = \alpha_{Inland} = \alpha_r \, \forall r = 1,2,3,4,5,6,7)$ is conducted for completeness.[43]

1. Fare
$Chi^2(6) = 5.86$
$Prob > Chi^2 = 0.4385$

There is no statistical evidence to reject the null hypothesis of the same fare coefficients across all routes. Thus, I may assume a common fare coefficient across all routes, α.

From the previous section (2.4.2.1. Jeju island routes), air travelers respond to flight frequency, aircraft size, and airtime duration in different ways across the Jeju island routes. Section 2.4.2.2. Inland routes shows that air travelers respond to flight frequency and aircraft size in different ways across the inland routes. Thus, there are *a priori* expectations of route-specific air travel demand sensitivities to flight characteristics. In short, I propose a joint constrained model in terms of price sensitivity where the parameter α is constrained to be the same across all seven routes, but the flight characteristics should be permitted to have

[43] The Wald test is performed using Stata11.

different effects for different routes (route-specific β_rs).

This chapter has carefully discussed the demand side. The nested logit model describes the demand structure of the air travel industry. The air travel demand models for nonstop Jeju island routes and inland routes are estimated, respectively, because these routes have different transportation modes and types of travelers. In the presence of two endogenous variables, three different demand model specifications that only differ in the instruments are discussed; the BLP style instruments, the Hausman style instruments, and the combined instruments of the BLP style and the Hausman style. Fare coefficients are estimated to be in a range between 0.057 to 0.159 (in absolute size). Most of the estimated coefficients for the flight characteristics have the expected sign. Greater choices of flight frequency and larger aircraft would give higher utility for air travelers. The shorter air time duration is, the more an air traveler would enjoy the service. Strong seasonality is observed on the Jeju island routes while weak seasonality is observed on the inland routes.

Chapter 3

The Supply Side

3.1 The Theoretical Model

3.1.1 Single Product Firm

In the air travel industry study with each carrier operating a differentiated flight, we present a theoretical model of the supply side based on consumer heterogeneity. Air travelers' preferred departure times are non-uniformly distributed around the 24-hour clock. With differentiation by departure times, air travel demand would be non-uniformly distributed, e.g., given a price air passengers find the flight that is most close to their preferred departure time convenience. This heterogeneity might show different patterns across the Jeju island routes and the inland routes. For the Jeju island routes, air travel demand is expected to be high for flights that either depart or arrive during lunchtime given that a time zone change effect is irrelevant in all domestic routes in Korea and even the longest direct route between Jeju island and Seoul takes less than 90 minutes. Vacationers may depart from the island before or around 11am-noon as they have to check out of hotels by 11am. In turn, they would prefer to fly around noon from an origin city in order to arrive at the island around 2pm-3pm because hotel guests can check in after 3pm. For the inland routes, business travelers probably differ from vacationers: their preferred departure times are expected to be concentrated into a few hours of a day, either early morning or late evening. Thus, air travel demand for the inland routes is expected to be lower for flights that either depart or arrive during lunchtime.

Along with the demand-driven motivation, fuel costs and capacity constraints provide an incentive for a carrier to schedule more frequent flights for the highest-demand hours (flights departing at lunchtime for the Jeju island routes) as opposed to less frequent flights for the low-demand hours. Since each route is a part of a network and the plane used on one route is in use in prior and subsequent routes, carriers strategically schedule departure flights and allocate flight frequencies between routes, taking into account overall (all domestic routes) profitability.

Airlines compete on prices as well as other quality factors, i.e., scheduling departure time or the number of flights (flight frequency). Carriers charge a wide range of prices on most routes, price discriminating by departure times. However, no disaggregated data at the route-carrier-departure flight time-day level is available. Korea airport corporation (KAC) data only contain aggregate information at the route-carrier-month level, including the number of passengers and the number of flights on each route. With insufficient data, we assume that there are J varieties of a differentiated flights offered by J different airlines, each of which charges a single price for all flights departing on the same day regardless of the departure times.[1]

At time $t = 1,\ldots,T$, each of J carriers is assumed to be a price setter in a static Bertrand price competition model.[2] Given the attributes and air fares of competing carrier's flights, airline carrier $j \in \{1,\ldots,J\}$ maximizes route and time specific profits Π^r_{jt} :

$$\Pi^r_{jt} = \left(p^r_{jt} - mc^r_{jt}\right) M s_{jt} - K^r_{jt}$$

[1] In this set-up, the cross effects, i.e., 9:30AM flight of Korean Air competes with another flight by the same carrier, Korean Air, i.e., 12:00PM flight on a route, drawing fliers off each other, are not captured.

[2] I assume that there exists a pure strategy interior equilibrium. A unique pure strategy equilibrium for the Bertrand game exists. Caplin and Nalebuff (1991)

where p^r_{jt} is the observed air fare, mc^r_{jt} is constant marginal cost, s_{jt} is the market share of flight j, and K^r_{jt} is fixed costs.[3] M is the potential market dimension.[4]

Route and time specific first order conditions satisfying the existence of a pure-strategy interior equilibrium for non-stop flight j operated by airline carrier j in time t are:

$$\frac{\partial \Pi^r_{jt}}{\partial p^r_{jt}} = s_{jt} + (p^r_{jt} - mc^r_{jt})\frac{\partial s_{jt}}{\partial p^r_{jt}} = 0$$

Then, a single product Bertrand Nash equilibrium (hereafter SBNE) is given by the system of J first order conditions, i.e., for each j on the route. The pricing equation (1) can be solely derived using the estimates from the demand side.

$$(p^r_{jt} - mc^r_{jt}) = -s_{jt}\frac{1}{\frac{\partial s_{jt}}{\partial p^r_{jt}}}$$

$$(p^r_{jt} - mc^r_{jt}) = \frac{p^r_{jt}}{\left|\eta^r_{jj,t}\right|} \ (7)$$

where $\left|\eta^r_{jj,t}\right| = \left|\frac{p^r_{jt}}{s_{jt}}\frac{\partial s_{jt}}{\partial p^r_{jt}}\right| = \left|-\frac{\alpha}{1-\sigma_r}p^r_{jt}\left(1-\sigma_r s_{jt/gt}-(1-\sigma_r)s_{jt}\right)\right|$ is route and time specific own price elasticities of air travel demand for flight j with respect to price change in flight j.[5]

Following standard assumptions in this literature, we assume that our data reflect firms competing in short run (period by period) Nash equilibria and our (nested logit) demand structure reflects consumer behavior. That is, our maintained hypotheses include the assumption of short run Nash equilibria and nested logit demand.

[3]For simplicity, mc^r_{jt} is assumed to be independent of output levels.

[4]In the demand model, specification is completed with an outside good, no flying choice. In particular, I define the route specific outside goods that are proportional to population and Gross Regional Domestic Product (GRDP) per capita of origin cities, and enplanement of the route. Thus, the potential market dimension for the Korean domestic air travel market is assumed to be proportional to those as well.

[5]There is no statistical evidence to reject the null hypothesis of the same fare coefficients across all routes in chapter 2. Thus, I assume a common fare coefficient across all routes, α. I propose a joint constrained model in terms of price sensitivity where the parameter α is constrained to be the same across all routes.

From the maintained hypothesis of nested logit demand we can find firm level demand elasticities in each time period. With firm level demand elasticities and the maintained hypothesis of short run Nash equilibria along with the data on price and the demand elasticities we can solve for the price markup over marginal costs, which means we can solve for the level of marginal costs under these assumptions.

The price-cost markups in equation (7) are calculated using the parameters of the demand system and the equilibrium price vector. Marginal cost of flight j, thus, can be directly solved with the estimates from the fare coefficient α, the nesting parameter coefficient σ_r and the level of variables, p^r_{jt}, s_{jt} and $s_{jt/gt}$.[6] All observed product characteristics, i.e., aircraft size, airtime duration and service flight frequency, affect both market shares s_{jt} and within nest share $s_{jt/gt}$. Therefore, the implied markups and marginal costs clearly are related to the assumed functional form for the demand specification. The pricing equation (1) would predict lower markup for a flight having a higher own price elasticity demand in equilibrium while it would predict a higher markup for a flight having a lower own price elasticity of demand. The carrier's ability to price its flight over marginal cost depends on the extent of its market power given rivals' prices. The size of markup is inversely related to own price elasticities faced by the firm.

For the Jeju island routes, $\eta^r_{jj,t}$ is calculated using the estimates from demand equation (3) $(ln(s_{jt}) - ln(s_{0t}) = X^r_{Jeju,jt}\beta_r - \alpha p^r_{jt} + \gamma z_{it} + \sigma_r ln(s_{jt/gt}) + \xi_{jt})$. For the inland routes, $\eta^r_{jj,t}$ is calculated using the estimates from demand equation (6) $(ln(s_{jt}) - ln(s_{0t}) = X^r_{Inland,jt}\beta_r - \alpha p^r_{jt} + \gamma z_{jt} + \sigma_r ln(s_{jt/gt}) + \xi_{jt})$.

[6] s_{jt} is the market share of flight j at time t. $s_{jt/gt}$ is the within the flying nest (g = 1) share of flight j and is calculated by dividing total passengers carried by each airline carrier by the total passengers of the flying inside goods.

3.1.2 Multiproduct Firms (Joint Ownership between Major Airlines and their Own Subsidiary LCCs)

Given that a hub-and-spoke system is not the optimal air transport network strategy for Korean domestic short haul routes, the two incumbents have developed new business strategies in response to the entry of LCCs. The legacy carriers, Korean Air (KAL) and Asiana Air (AAR), entered their own markets with LCC operations either replacing their prior service or competing with it for some city pair routes. Asiana Air, the second largest legacy carrier, rebadged to Air Busan (ABL), its own subsidiary LCC, for some routes while Korean Air, the largest legacy carrier, flies some routes under both badges: Korean Air and Jin Air (JNA), its own subsidiary LCC.

In the presence of a multiproduct firm such as KAL in which more than one variety is offered by a single entity, the Multiproduct Bertrand-Nash Equilibrium concept (hereafter MBNE, the term used by Garcia-Callego and Georgantzia (2001)) needs to be differentiated from the Single-product Bertrand-Nash Equilibrium (hereafter SBNE).[7] According to the MBNE concept, incumbents would develop a large variety of products and occupy gaps in the market that potential entrants and/or existing competitors may have exploited, thus showing a direct competitive response. Under the multiproduct oligopoly set-up, a multiproduct firm selling X and Y may find a rise in price for X profitable if lost sales induced by this increase are diverted to product Y, thereby potentially compensating for the lost sales of X. If the multiproduct firms' products are close substitutes for each other relative to other alternatives sold by rival firms, a substantial amount of the lost sales in product X will be diverted to product Y.[8] As a consequence, the multiproduct firm may have an incentive to charge higher prices than those predicted by the SBNE.

Let us describe the industry configuration where both a multiproduct firm and a single

[7] See García-Gallego and Georgantzís [2001].

[8] In addition, diversion ratios have been widely used in many competition cases including merger investigation/simulations studies. Diversion ratios were part of the evidence in the Ryan air/Aer Lingur merger case, after which the European Commission blocked the merger.

product firm co-exit. Assume that there are J varieties of differentiated flights offered by $J-1$ airlines during $t=1,\ldots,T$ periods. In particular, suppose that KAL maximizes route-specific profit at each moment in time t, choosing the prices of both KAL flights and JNA flights which take into account the prices set by all their competitors in a static Bertrand Nash equilibrium model.[9] For each month t, Korean Air f schedules a subset $\mathbb{Q}^r_{ft}=\{m,l\}$ of $j=1,..m,l,..,J$ flights to maximize route and time specific profits:

$$\Pi^r_{ft}=(p^r_{mt}-mc^r_{mt})Ms_{mt}+(p^r_{lt}-mc^r_{lt})Ms_{lt}-K^r_{mt}-K^r_{lt}$$

where p^r_{mt} is the observed air fare for a KAL flight m, p^r_{lt} is the observed air fare for a JNA flight l, mc^r_{mt} is constant marginal cost for a KAL flight m, mc^r_{lt} is constant marginal cost for a JNA flight l, s_{mt} is the market share of a KAL flight m, s_{lt} is the market share of a JNA flight l. K^r_{mt} is fixed cost for a KAL flight m and K^r_{lt} is fixed cost for a JNA flight l. M is the potential market dimension.

The route and time specific first order condition satisfying the existence of a pure-strategy interior equilibrium for a KAL flight m operated by Korean Air f in time t is

$$\frac{\partial \Pi^r_{ft}}{\partial p^r_{mt}}=s_{mt}+(p^r_{mt}-mc^r_{mt})\frac{\partial s_{mt}}{\partial p^r_{mt}}+(p^r_{lt}-mc^r_{lt})\frac{\partial s_{lt}}{\partial p^r_{mt}}=0 \; (8)$$

The route and time specific first order condition satisfying the existence of a pure-strategy interior equilibrium for a JNA flight l operated by Korean Air f in time t is

$$\frac{\partial \Pi^r_{ft}}{\partial p^r_{lt}} \quad = \quad (p^r_{mt}-mc^r_{mt})\frac{\partial s_{mt}}{\partial p^r_{lt}}+s_{lt}+(p^r_{lt}-mc^r_{lt})\frac{\partial s_{lt}}{\partial p^r_{lt}}=0 \; (9)$$

In assessing the pricing strategy of a multiproduct firm, a diversion ratio would illustrate and predict how the firm, Korean Air in our context, strategically charges different prices for

[9]A unique pure strategy equilibrium for the Bertrand game exists. Caplin and Nalebuff (1991).

its own flights (KAL flights, m) and its subsidiary LCC flights (JNA flights, l). Diversion ratios based on the demand estimation are calculated from own- and cross- price elasticities of demand for each product. Specifically, in a discrete choice demand model specification, a diversion ratio can be directly calculated.

For example, KAL flights (m) to JNA flights (l) is measured by the ratio of the cross-price elasticity of demand for JNA flights (l) (with respect to KAL flights' price change) to the own-price elasticity of demand for KAL flights (m) multiplied by the ratio of the market share for JNA flights (l) to the market share for KAL flights (m).

$$diversion\ ratio_{ml} = \frac{\eta_{ml}}{|\eta_{mm}|} \cdot \frac{s_l}{s_m}$$

where $\eta_{ml} = \frac{\partial s_l}{\partial p_m} \cdot \frac{p_m}{s_l}$ is cross-price elasticity of demand for flight l with respect to flight $m's$ price change. Flights m and l are assumed to be substitutes for each other, thus having positive cross-price elasticities.[10] $|\eta_{mm}| = \left|\frac{\partial s_m}{\partial p_m} \cdot \frac{p_m}{s_m}\right|$ is own-price elasticity of demand for flight m with respect to its own price change.[11] The diversion ratio ranges from a high of 1 to a low of 0, with the value of 1 meaning that all the lost sales for KAL flights (m) go to JNA flights (l). That is, this quantifies how much of the demand for KAL flights switches to JNA flights in response to the increase in price for KAL flights. Similarly, it measures the proportion of air passengers choosing KAL flights who would consider JNA flights their second best choice when the price for KAL increased. The higher the diversion ratio between KAL flights and JNA flights, the closer substitutes they are.

In the same manner, the diversion from JNA flights (l) to KAL flights (m) as a result of a price increase for JNA flights (l) can be expressed as the product of the ratio of the cross-price elasticity to the own-price elasticity and the ratio of the demand for KAL flights (m) to the demand for JNA flights (l) when Korean Air f raises the price for JNA flights (l).

[10]On the demand side, each air passenger is assumed to choose a flight which would provide the highest utility. In this context, it is reasonable to consider flights m and l substitutes rather than complements.

[11]The own price elasticity is negative for normal good.

$$diversion\ ratio_{lm} = \frac{\eta_{lm}}{|\eta_{ll}|} \cdot \frac{s_m}{s_l}$$

where $\eta_{lm} = \frac{\partial s_m}{\partial p_l} \cdot \frac{p_l}{s_m}$ is cross-price elasticity of demand for flight m with respect to flight $l's$ price change. $|\eta_{ll}| = \left| \frac{\partial s_l}{\partial p_l} \cdot \frac{p_l}{s_l} \right|$ is own-price elasticity of demand for flight l with respect to its price change.

Using these diversion ratios, the optimal pricing rules for each variety of Korean Air selling two products, KAL flights (m) and JNA flights (l), are reduced to equations ($8^{'}$) and ($9^{'}$).

$$p^r_{mt} - mc^r_{mt} = \frac{p^r_{mt}}{|\eta_{mm}|} + (p^r_{lt} - mc^r_{lt}) \frac{\eta_{ml}}{|\eta_{mm}|} \frac{s_l}{s_m} \ (8')$$

$$p^r_{lt} - mc^r_{lt} = \frac{p^r_{lt}}{|\eta_{ll}|} + (p^r_{mt} - mc^r_{mt}) \frac{\eta_{lm}}{|\eta_{ll}|} \frac{s_m}{s_l} \ (9')$$

These pricing equations for each variety of a multiproduct firm, Korean Air f, should be differentiated from that of a single product firm, since it captures the degree of the multiproduct firm activity. Korean Air f will charge a different price for each flight under distinct badges, taking into account the cross price effects among them interacting on the air travel demand. In contrast to the optimal pricing rules under the SBNE, the pricing equations ($8^{'}$) and ($9^{'}$), derived under the MBNE, have additional terms involving multiproduct firm activity. These equations consist of two parts: An own product-specific effect and a multiproduct firm-specific effect. The first term is identical to the markup term of the pricing equation (7) under the SBNE. It is inversely proportional to its own price elasticity. The second term's multiproduct firm-specific markups of equations ($8^{'}$) and ($9^{'}$) are only relevant under the MBNE. With regard to the equation ($8^{'}$), this additional markup term can be expressed as the price-cost margin for JNA flights (l) which are multiplied by KAL flights (m)'s diversion ratio to JNA flights (l). Given that all varieties are substitutes for each other, the pricing equation ($8^{'}$) under the MBNE predicts a higher markup by the amount of the additional markup term than the SBNE. The more diversion to JNA flights (l) there are, the more likely it is for Korean Air to be able to hedge the loss in KAL flights sales with a larger multiproduct firm-specific markup. In a similar manner to equation ($8^{'}$), the additional markup term in equation ($9^{'}$) can be expressed as the price-cost margin for KAL flights (m) which are multiplied by JNA flights (l)'s diversion ratio to KAL flights (m). In the presence of these additional markup terms, the MBNE are constructed to predict a higher markup for each product of Korean Air f than the SBNE.

On the other hand, the route- and time-specific profit Π^r_{jt} of a single-product firm j is given by:[12]

$$\Pi^r_{jt} = \left(p^r_{jt} - mc^r_{jt}\right) M s_{jt} - K^r_{jt}$$

where p^r_{jt} is the observed air fare, mc^r_{jt} is constant marginal cost, s_{jt} is the market share of flight j, K^r_{jt} is fixed costs. M is the potential market dimension.

The route- and time-specific first order conditions satisfying the existence of a pure-strategy interior equilibrium for single flight firm's flight j is

$$\frac{\partial \Pi^r_{jt}}{\partial p^r_{jt}} = s_{jt} + \left(p^r_{jt} - mc^r_{jt}\right) \frac{\partial s_{jt}}{\partial p^r_{jt}} = 0$$

The system of J first order conditions for time t can be stacked in the following way:

$$p - c = \Omega^{-1} s$$

where s is a $J \times 1$ vector containing s_{jt} terms, $p - c$ is a $J \times 1$ vector containing $\left(p^r_{jt} - mc^r_{jt}\right)$ terms, and Ω is a $J \times J$ matrix whose ml th element is given by:

[12]Each airline carrier other than Korean Air is treated as a single-product firm, operating its own flight.

$\Omega_{ml} = -\frac{\partial s_{lt}}{\partial p^{r}_{mt}}$ if m and l are produced by the legacy carrier f , Korean Air

$\Omega_{ml} = 0$ otherwise

The pricing equations and the demand equation(3) (equation(6)) for the Jeju island routes (for the inland routes) can be either simultaneously estimated or separately estimated when demand parameters are obtained first and then inserted in the pricing equation. Since no cost data are available, price cost margins are recovered after the estimation of demand parameters.[13]

3.1.3 Legacy Carrier Behavior

Many studies on deregulation in the airline industry have analyzed price effects and capacity expansion effects. One would expect that an introduction of a new entrant induced by deregulation would lead to decreases in the prices of incumbent airlines. In response to the entry of LCCs, incumbents may significantly reduce fares. On the other hand, incumbents might increase capacity, i.e., flight frequency, in order to deter entry.[14]

Over the recent past few years the Korean legacy carriers have been faced with challenges from LCC growth and unexpected high fuel costs. It is difficult to differentiate the survival strategies from responses to price-driven competition from independent LCCs. In particular, the two established full service carriers in Korea adapted strategies in response the emergence of independent LCCs, where one of the possible responses was the creation of a dependent LCC in the deregulated period. The two legacy carriers, Korean Air (KAL) and Asiana Air (AAR), created their own subsidiary LCCs in order to compete with independent low cost operators on some domestic routes. KAL's multi-brand strategy and AAR's rebadging strategy were limited to the routes having either Seoul or Busan, the two largest metropolitan

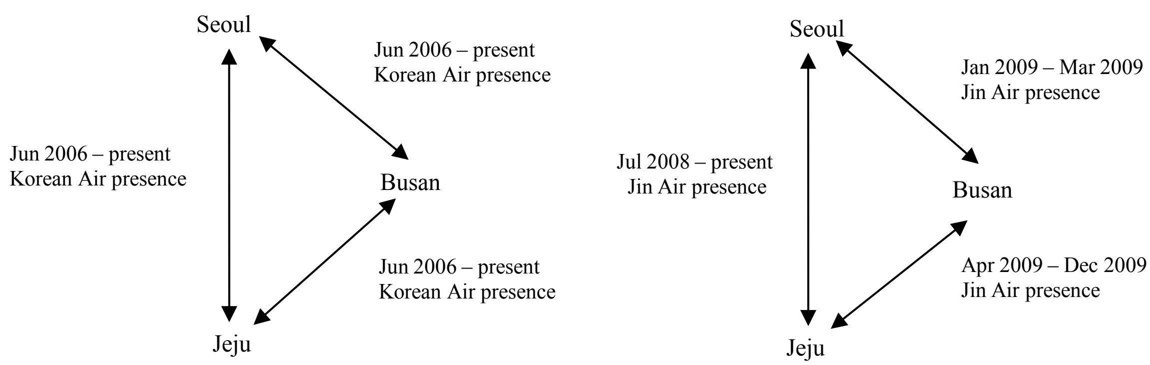
[13] See Nevo 2000a.

[14] Dynamic considerations such as strategic excess capacity modeling or limit pricing modeling are not captured by either the single (3.1.1) or multiple static equilibria (3.1.2) presented in previous section.

areas in South Korea, as an end point city.

Furthermore, these two legacy carriers show different strategies in response to the intensified competition by independent LCCs. The KAL's strategy of responding with a start-up subsidiary, Jin air (JNA), has had only limited success as of Oct 2010 (Figure 3.1). JNA was launched in July 2008 and competed with its parent company, KAL, on the routes where both KAL and JNA operated flights under their own badges, i.e., Jeju-Seoul, Seoul-Busan, and Busan-Jeju. Other than the Jeju-Seoul route, JNA only flew few months on the Seoul-Busan route (Jan 2009 - March 2009) and the Jeju-Busan route (April 2009-Nov 2009).

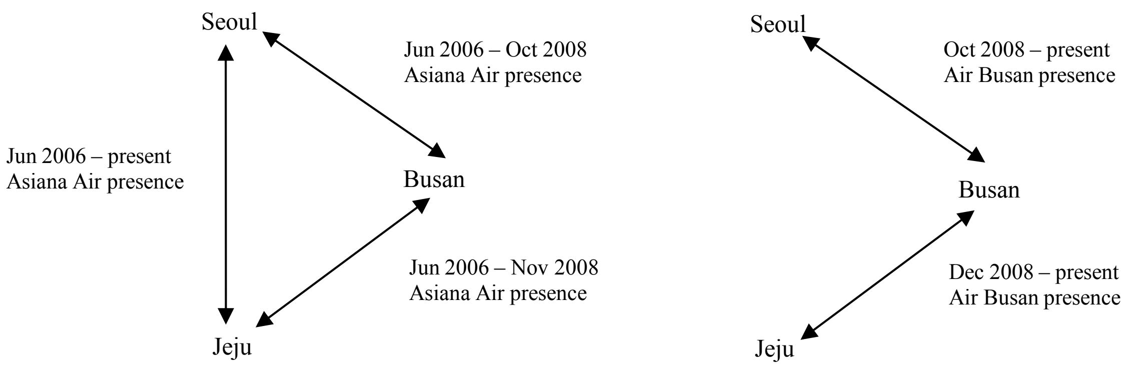
Figure 3.1: Joint strategy of Korean Air and Jin Air



Air Busan (ABL) operated out of Busan airport, its base airport, and shared service with its parent company, AAR, in the form of a code-share operation system, yielding remarkable synergies.[15] Since the launch of its business in Oct 2008, ABL, AAR's subsidiary, began flight service between Busan and Seoul, operating the Jeju-Busan route two months later (Figure 3.2).

[15]See chapter 4. I provide the estimates of the Lerner indices and market shares for AAR and ABL in chapter 4. As of October 2010, ABL continues to fly the routes out of Busan, showing considerable growth of market share over the past few years.

Figure 3.2: Joint strategy of Asiana Air and Air Busan



3.1.3.1 Jeju Island Routes

After Korea officially established a five day work week system in 2004, peoples' leisure activities changed greatly. With having increased leisure hours, employees are highly enthused by the new system, in looking forward to their personal time. A five day work week system, combined with the emergence of LCCs, has prompted more people to fly due in part to a substantial reduction in fares. It has also pushed the legacy carriers to adjust in order to dominate air transport service even in the post-deregulation period. In particular, competition among the two legacy carriers and independent LCCs for the Jeju island routes has intensified due to the dominance of air transportation for travel to and from Jeju island, the country's largest island and tourist destination.[16]

Within the Jeju island routes, air travel demands for five direct routes ($r = 1,2,3,4,5$) are estimated in chapter 2, respectively: Jeju-Seoul ($r = 1$), Jeju-Busan ($r = 2$), Jeju-Cheongju ($r = 3$), Jeju-Daegu ($r = 4$), and Jeju-Gwangju ($r = 5$) route. For the Jeju-Gwangju route, where no entrant was observed, there is no point in looking at legacy carrier strategic behavior in response to the entry of LCCs.

[16]To get to Jeju island the ferry is really not a viable option and the Jeju island routes are primarily for vacation travelers.

1. Jeju-Seoul Route (r = 1)

Jeju-Seoul is the largest domestic sector for LCCs. KAL, the country's largest legacy carrier, launched its own LCC, Jin Air (JNA) and started service from Jeju to Seoul, and vice versa, in July 2008, two months after the Deregulation Act of May 2008. Several LCCs have been established over the last three years: two independent LCCs, Eastar Jet (ESR) and Jeju Air (JJA), as well as one dependent LCC, Jin Air, while two independent LCCs ceased operations in November 2008 (Hansung Air (HAN)) and December 2008 (Yeongnam Air (ONA)) due to intense competition, worsening economic conditions, increasing fuel costs, and difficulties in securing additional funding. HAN was formally re-launched in September 2010 under the changed new name, T'way Air (TWB). As of October 2010, Korean Air still continued to fly Jeju-Seoul route under both of badges: KAL and JNA (Table 3-1).

Table 3.1: Entry/Exit during 2006-2010: Jeju-Seoul route (r = 1)

Time	Jeju-Seoul route
(Year-Month)	Airline
2006 June	AAR (Major)
	KAL (Major)
	JJA (LCC)
Entry / Exit	
2006 Oct - Entry	HAN (LCC)
2008 May Deregulation Act	
2008 July - Entry	JNA (LCC), KAL (Major)'s subsidiary LCC, launched Jeju-Seoul service.
	ONA (LCC)
2008 Nov - Exit	HAN (LCC)
2008 Dec - Exit	ONA (LCC)
2009 Jan - Entry	ESR (LCC)
2010 Sep - Entry	HAN (LCC) re-launched under the changed name, TWB (LCC).

Table 3.2: Competitive consequences illustrated by the entry/exit: Jeju-Seoul route (r = 1)

1. Jeju-Seoul route			Air fare level of new entry		The number of flights (% change)
ENTRY year month	Airline (LCC)	EXIT year month	% of competing airlines		Legacy carriers respond to new entry of LCC:
			Major Airlines	Existing LCCs	
2006 Oct	HAN	2008 Nov	Fare was 80.02% of major airlines.	Fare was 114.30% of JJA.	(i) KAL scheduled 7.01% more flights in face of entry. (ii) AAR scheduled 1.52% fewer flights in face of entry.
2008 May Deregulation					
2008 July	ONA	2008 Dec	Fare was 80.42% of major airlines.	Fare was 121.66% of HAN Fare was 118.76% of JJA.	(i) KAL launched its own subsidary LCC, Jin Air (JNA) in July 2008 and flew under both badge: KAL and JNA. JNA's fare was 67.76%, 102.01%, and 100.06% of major airlines, HAN, and JJA, respectively. The total number of flights on both KAL and JNA increased by 5.56% as compared to previous month's KAL. (ii) AAR scheduled 7.24% more flights in face of entries.
2009 Jan	ESR	Service	Fare was 81.02% of major airlines.	Fare was 98.35% of JJA. Fare was 101.16% of JNA.	(i) KAL scheduled 4.44% fewer flights in face of entry. JNA scheduled 12.18% fewer flights in face of entry. The total number of flights on both KAL and JNA decreased by 6.86% as compared to previous month. (ii) AAR scheduled 8.00% fewer flights in face of entry.
2010 Sep	TWB	Service	Fare was 87.66% of major airlines.	Fare was 104.66% of JJA. Fare was 104.87% of JNA. Fare was 105.90% of ESR.	(i) KAL scheduled 8.46% fewer flights in face of entry. JNA scheduled 4.26% fewer flights in face of entry. The total number of flights on both KAL and JNA decreased by 7.00% as compared to previous month. (ii) AAR scheduled 8.41% fewer flights in face of entry.

The introduction of fuel surcharges has had a negative impact on the pricing strategies of LCCs in post-deregulation period. As of July 2008, the two major airlines started to impose airline specific fuel surcharges \$14 on all domestic flights in response to rising oil and jet fuel prices. In August 2008, the independent LCCs also imposed fuel surcharges, in the amount of \$13 (ONA), \$10 (HAN), and \$11 (Jeju Air (JJA)) on all flights. As shown in Table 3.2, the fares of the new independent LCCs increased far more than those of the two rival major airlines, losing price competitiveness.

In July 2008, the KAL' dependent LCC, JNA began offering tickets at 67.7% of the price offered by the major carriers. The air fare level of JNA was same as the two existing independent LCCs, JJA and HAN. Total number of flights scheduled by Korean Air under both KAL and JNA badges increased by 5.5% in face of the entry of ONA in July 2008. Both legacy carriers decreased their flight frequency following entry of LCCs in 2009 when only competitive independent LCCs continued to fly the Jeju-Seoul route.

2. Jeju-Busan Route (r = 2)

Jeju-Busan is the second largest domestic sector for LCCs. In November-December 2008, AAR, the second largest legacy carrier, rebadged to ABL, its own subsidiary LCC. In contrast to AAR and ABL, the joint ownership strategies of KAL and JNA, present a different pattern. Korean Air started to fly the Jeju-Busan route under the JNA badge in April 2009, maintaining its KAL badge as well. Korean Air only flew the route under the JNA badge for 9 months. On the contrary, Air Busan still continues to fly this route, showing considerable growth of market share over the past few years (Table 3.3).

Table 3.3: Entry/Exit during 2006-2010: Jeju-Busan route (r = 2)

Time	Jeju - Busan route
(Year-Month)	Airline
2006 June	AAR (Major)
	KAL (Major)
Entry / Exit	
2006 Aug - Entry	JJA (LCC)
2008 May Deregulation Act	
2008 July - Entry	ONA (LCC)
2008 Dec - Entry	AAR (Major) rebadged to ABL (LCC), its subsidiary LCC.
2008 Dec - Exit	ONA (LCC)
2009 April - Entry	JNA (LCC), KAL (Major)'s subsidiary LCC, launched Jeju-Busan service.
2010 Jan - Exit	JNA (LCC)

Table 3.4: Competitive consequences illustrated by the entry/exit: Jeju-Busan route (r = 2)

<table>
<tr><th colspan="3">2. Jeju-Busan route</th><th colspan="2">Air fare level of new entry</th><th>The number of flights (% change)</th></tr>
<tr><th rowspan="2">ENTRY
year month</th><th rowspan="2">Airline
(LCC)</th><th rowspan="2">EXIT
year month</th><th colspan="2">% of competing airlines</th><th rowspan="2">Legacy carriers respond to new entry of LCC:</th></tr>
<tr><th>Major Airlines</th><th>Existing LCCs</th></tr>
<tr><td>2006 Aug</td><td>JJA</td><td>Service</td><td>Fare was 73.22%
of major airlines.</td><td>NA</td><td>(i) KAL scheduled 7.97% more flights in face of entry.
(ii) AAR scheduled 3.61% more flights in face of entry.</td></tr>
<tr><td colspan="6">2008 May Deregulation</td></tr>
<tr><td>2008 July</td><td>ONA</td><td>2008 Dec</td><td>Fare was 94.24%
of major airlines.</td><td>Fare was 136.91%
of JJA.</td><td>(i) KAL scheduled 3.65% fewer flights in face of entry.
(ii) AAR scheduled 5.32% more flights in face of entry.</td></tr>
<tr><td>2008 Dec</td><td>ABL</td><td>AAR rebadged to ABL.</td><td>Fare was 93.08%
of KAL.</td><td>Fare was 115.51%
of JJA.</td><td>(i) KAL scheduled 16.54% fewer flights in face of entry.
.
(ii) AAR rebadged to ABL, its own subsidiary LCC.
The total number of flights on ABL increased by 2.31%
as compared to previous month's AAR.</td></tr>
<tr><td>2009 April</td><td colspan="2">KAL started to fly the route
under both badges:
KAL and JNA.

JNA ceased the route service
(2010 Jan).</td><td>Fare was 80.22%
of KAL.</td><td>Fare was 100%
of JJA.
Fare was 87.25%
of ABL.</td><td>(i) KAL scheduled 8.51% fewer flights
following the service of JNA, its subsidiary LCC.
The total number of flights on both KAL and JNA
increased by 42.79% as compared to previous month's KAL.
(ii) AAR's subsidiary LCC, Air Busan (ABL), scheduled
6.60% fewer flights in face of entry, JNA.</td></tr>
</table>

As seen in Table 3.4, new LCC entries including both independent and dependent LCCs had less price competitiveness in the post-deregulation period. Yeongnam Air (ONA), independent LCC, began offering tickets at 94.2% of the prices offered by the major carriers at times of unusually high fuel surcharges. The air fare level of ONA was 36% higher than that of Jeju Air (JJA), another independent LCC. As a consequence, ONA only flew the Jeju-Busan route for five months and ceased operations in December 2008 due to increasing fuel costs and weak demand.

AAR rebadged to ABL, its subsidiary LCC, in Dec 2008. The air fare of ABL was slightly lower than the air fare provided by KAL, the largest legacy carrier, and 15% higher than the air fare provided by independent LCC competitor, JJA. KAL scheduled 16% fewer flights in face of the entry of ABL in December 2008 when it started the flight services for the Jeju-Seoul and Seoul-Busan routes under its low cost unit, JNA.

The air fare level of JNA was lower relative to another dependent LCC, ABL, but the same as the air fare provided by the independent LCC competitor, JJA. JNA ceased the Jeju-Busan route service in January 2010 while another dependent LCC, ABL, had a code-share operation with its parent company AAR, taking the largest market share in this route.

3. Jeju-Cheongju Route (r = 3)

On the Jeju-Cheongju route, only two entries of independent LCCs are observed during the full time period: Jeju Air (JJA) in June 2008 and Eastar Jet (ESR) in June 2009. Korea's first independent LCC, Hansung Air (HAN) ceased operations in November 2008. No subsidiary LCCs of the two legacy carriers has started flying on the Cheongju route (Table 3.5).

Table 3.5: Entry/Exit during 2006-2010: Jeju-Cheongju route (r = 3)

Time	Jeju - Cheongju route
(Year-Month)	Airline
2006 June	AAR (Major)
	KAL (Major)
	HAN (LCC)
Entry / Exit	
2008 May Deregulation Act	
2008 June - Entry	JJA (LCC)
2008 Nov - Exit	HAN (LCC)
2009 June - Entry	ESR (LCC)

Table 3.6 illustrates legacy carrier strategic behaviors in response to the entry of independent LCCs. JJA and ESR began offering tickets at 80% of the air fares by major airlines in June 2008 and in June 2009, respectively. The two legacy carriers slightly decreased their flight frequencies on the route and this would be consistent with the expectation that incumbents scheduled fewer frequent flights rather cutting prices substantially.

Table 3.6: Competitive consequences illustrated by the entry/exit: Jeju-Cheongju route (r = 3)

3. Jeju-Cheongju route			Air fare level of new entry		The number of flights (% change)
ENTRY year month	Airline (LCC)	EXIT year month	% of competing airlines		Legacy carriers respond to new entry of LCC:
			Major Airlines	Existing LCCs	
2008 May Deregulation					
2008 June	JJA	Service	Fare was 80.12% of major airlines.	Fare was 94.81% of HAN.	(i) KAL scheduled 3.48% fewer flights in face of entry. (ii) AAR scheduled 3.25% fewer flights in face of entry.
2009 June	ESR	Service	Fare was 79.00% of major airlines.	Fare was 98.57% of JJA.	(i) KAL scheduled 3.23% fewer flights in face of entry. (ii) AAR scheduled 3.23% fewer flights in face of entry.

4. Jeju-Daegu Route (r = 4)

Only one entry of a LCC is observed during the full time period: Yeongnam Air (ONA) on the Jeju-Daegu route. ONA, an independent LCC, launched its flight services for the Jeju-Seoul, Jeju-Busan, and Jeju-Daegu routes in July 2008, two months after the Deregulation Act of May 2008, but ceased its operations in December 2008 (Table 3.7).

Table 3.7: Entry/Exit during 2006-2010: Jeju-Daegu route (r = 4)

Time	Jeju - Daegu route
(Year-Month)	Airline
2006 June	AAR (Major)
	KAL (Major)
Entry / Exit	
2008 May Deregulation Act	
2008 July - Entry	ONA (LCC)
2008 Dec - Exit	ONA (LCC)

Unlike the two major airlines, ONA operated only one propeller-powered aircraft, a Fokker 100 (turboprop aircraft with less than 80 seats). ONA flew once each day on the Jeju-Daegu route (Table 3.8).

Table 3.8: Competitive consequences illustrated by the entry/exit: Jeju-Daegu route (r = 4)

4. Jeju-Daegu route			Air fare level of new entry		The number of flights (% change)
ENTRY year month	Airline (LCC)	EXIT year month	% of competing airlines		Legacy carriers respond to new entry of LCC:
			Major Airlines	Existing LCCs	
2008 May Deregulation					
2008 July	ONA	2008 Dec	Fare was 78.32% of major airlines	NA	(i) KAL scheduled 0.76% more flights in face of entry. (ii) AAR scheduled 2.48% more flights in face of entry.

3.1.3.2 An Inland Route

The inland route services may provide two opposing incentives for entrants to consider. First, there are substitutable transportation modes. Alternatives include bus, rail, and automobile transportation. For example, high-speed rail services, Korean Train eXpress (KTX), was introduced in 2004. Second, with respect to the type of passengers, the inland routes attract a large number of business travelers.

Within the inland routes, air travel demands for two routes ($r = 6,7$) are estimated in chapter 2, respectively: Seoul-Busan ($r = 6$) and Seoul-Gwangju ($r = 7$). Like the Jeju-Gwangju route, the Seoul-Gwangju route also has only been operated by the two legacy carriers, KAL and AAR. Thus, I will not focus on legacy carrier behavior for the Seoul-Gwangju route.

1. Seoul-Busan Route (r = 6)

The Seoul-Busan route is the third largest domestic route and the largest inland route. In October - November 2008, AAR rebadged to ABL, its own subsidiary LCC. On the other hand, KAL used a different strategy. Korean Air started to fly under both KAL and JNA badges in January 2009, but it only flew under the JNA badge for three months (Table 3.9).[17]

[17]No independent LCCs after deregulation entered the Seoul-Busan route.

Table 3.9: Entry/Exit during 2006-2010: Seoul-Busan route (r = 6)

Time	Seoul-Busan route
(Year-Month)	Airline
2006 June	AAR (Major)
	KAL (Major)
	JJA (LCC)
Entry / Exit	
2007 Feb - Exit	JJA (LCC)
2008 May Deregulation Act	
2008 Oct - Nov, Entry	AAR (Major) rebadged to ABL (LCC), its subsidiary LCC.
2009 Jan - Entry	JNA (LCC), KAL (Major)'s subsidiary LCC, launched Seoul-Busan service.
2009 April - Exit	JNA (LCC)

As shown in Table 3.10, the second largest legacy carrier, AAR, rebadged to ABL, charging air fare at 82.7% of KAL. It scheduled 13.4% more frequent flights than in the previous month. Two months later, JNA, KAL's subsidiary LCC, began offering tickets at 86% of the air fares provided by ABL in Jan 2009. The total number of flights increased by 12.9% compared to the previous month's flight frequency under the KAL badge. Jin Air that started the Seoul-Busan route service in Jan 2009 only flew on the Seoul-Busasn route for three months and stopped the route service in April 2009. As of October 2010, ABL is the sole LCC representative.

Table 3.10: Competitive consequences illustrated by the entry/exit: Seoul-Busan route (r = 6)

6. Seoul-Busan route			Air fare level of new entry		The number of flights (% change)
ENTRY year month	Airline (LCC)	EXIT year month	Compared to competing airlines: Major Airlines	Existing LCCs	Legacy carriers respond to new entry of LCC:
2008 May Deregulation					
2008 Oct	ABL	AAR rebadged to ABL. (2008 Nov)	Fare was 82.68% of KAL.	NA	(i) KAL scheduled 1.85% more flights in face of entry. . (ii) AAR rebadged to Air Busan (ABL), its own subsidiary LCC. The total number of flights on ABL increased by 13.45% as compared to previous month.
2009 Jan	KAL started to fly the route under both badges: KAL and JNA. JNA ceased the route service. (2009 April)		Fare was 75.95% of KAL.	Fare was 86% of ABL.	(i) KAL scheduled 1.33% fewer flights following the service of JNA, its subsidiary LCC. The total number of flights on both KAL and JNA increased by 12.95% as compared to previous month. (ii) ABL, AAR's subsidiary LCC, scheduled 0.18% fewer flights in face of entry, JNA.

3.1.3.3 Jeju Island Routes and an Inland Route

In summarizing the effects of LCCs entry on domestic routes in the post-deregulation period, there are few successful independent LCCs: Jeju Air (JJA) and Eastar Jet (ESR), which are not owned by either of the legacy carriers.[18] In response to the intensified competition, the two legacy carriers also launched their own subsidiary LCCs in July 2008 (JNA for KAL) and in Oct 2008 (ABL for AAR). AAR, the second largest legacy carrier, rebadged to ABL and had code-share operations for the Jeju-Busan and Seoul-Busan route. In contrast to AAR and ABL, the joint ownership strategies of KAL and JNA present a different pattern. Korean Air started to fly under the JNA badge, maintaining its KAL badge as well.

The two legacy carriers focused on the routes having either Seoul or Busan, the two largest metropolitan areas in Korea, as endpoint cities in the post-deregulation period. As

[18] Hansung Air (HAN) ceased operation in 2008 and re-launched in September 2010 with a changed name, T'way Air (TWB). T'way Air began flight service between Seoul and Jeju in September 2010.

of October 2010, four LCCs (three independent LCCs plus one dependent LCC) were flying the Jeju-Seoul route, two LCCs (one independent LCC plus one dependent LCC) were flying the Jeju-Busan route, three LCCs (all three are independent LCCs) were flying the Jeju-Cheongju route, and one LCC (a dependent LCC) was flying the Seoul-Busan route.

Chapter 4

Integrating the Demand Side and Supply Side

4.1 Price Elasticities and Markups

Estimates from demand equation (3) (equation (6)) for the Jeju island routes (inland routes) in chapter 2 are used to compute route and time specific own- and cross-price elasticities.[1] Price-cost markups are recovered after the demand parameters are first obtained and then inserted in the pricing equation (7) (equations (8) and (9)) for the single product firm assumption (jointly solved for the multiproduct firm assumption).

In the nested logit model, an air passenger's utility is assumed to be correlated among similar flights belonging to the same nest. The main consequence of this assumption involves

[1]Own- and cross- price elasticities for the nested logit model specification for air travel demand are:

$$\eta^r_{jj,t} = \left| \frac{p^r_{jt}}{s_{jt}} \frac{\partial s_{jt}}{\partial p^r_{jt}} \right| = \left| -\frac{\alpha}{1-\sigma_r} p^r_{jt} \left(1 - \sigma_r s_{jt/gt} - (1-\sigma_r) s_{jt}\right) \right|$$
$$\eta^r_{jk,t} = \frac{p^r_{jt}}{s_{kt}} \frac{\partial s_{kt}}{\partial p^r_{jt}} = \frac{\alpha}{1-\sigma_r} p^r_{jt} \left(\sigma_r s_{jt/gt} + (1-\sigma_r) s_{jt}\right)$$
$$\eta^r_{jq,t} = \frac{p^r_{jt}}{s_{qt}} \frac{\partial s_{qt}}{\partial p^r_{jt}} = \alpha p^r_{jt} s_{jt}$$

where $s_{jt/gt}\left(s_{kt/gt}\right)$ is the within group share for flight j (k). Flights j and k belong to the same segment while q belongs to another segment (q means outside good option in our context). The price coefficient α enters the demand equation as $\alpha > 0$ and the nesting parameter $0 < \sigma_r < 1$ measures the correlation of the air passengers' utilities across flights compared with the potential passengers who did not choose air travel at time t.

the pattern of cross price elasticities of demand. Higher cross price elasticities are expected for similar flights within the same group. For example, an increase in the price of flight j affects air passengers who currently purchase flight j in that these passengers will substitute similar flights grouped in the same nest (air travel choice group), rather than choose the outside option in the other nest (no flying decision).

Even though cross price elasticities are mainly driven by flight market shares,[2] the nested logit model specification can be widely used in demand and supply analyses for its computational tractability. In addition, the primary goal of an airline competition study is illustrated in this specification in that I focus on evaluating the May 2008 Deregulation Act and the legacy carriers' strategic responses to the emergence of low cost carriers.

4.1.1 Jeju Island Routes

Within the Jeju Island routes, the demands for five direct routes (r = 1, 2, 3, 4, 5) are estimated in this order: Jeju-Seoul (r = 1), Jeju-Busan (r = 2), Jeju-Cheongju (r = 3), Jeju-Daegu (r = 4), and Jeju-Gwangju (r = 5). A wide range of air transport industry configurations are observed for these routes over time. The strategies for the two legacy carriers that involve responding with subsidiary LCCs are limited to two routes, Jeju-Seoul (r = 1) and Jeju-Busan (r = 2), where Korean Air operated under two brands, KAL and JNA, and AAR replaced its prior operation with ABL. In other words, KAL tried to establish the JNA brand separate from its parent company, while AAR maintained the linkage between parent company and ABL through the code-share operation. For the Jeju-Cheongju route (r = 3), where competition between the two legacy carriers and the independent LCCs has intensified since the May 2008 Deregulation, the capability of the LCC business model in the Korean air transport industry is testable. Thus, I limited the analysis to the three routes where independent LCCs operated at least a half year: Jeju-Seoul, Jeju-Busan, and Jeju-Cheongju. I provide route

[2] Any two differentiated flights belonging to the same group with the same market shares and within group shares have the same cross price elasticities with any third flight in the nested logit model specification.

by route tables for these two carriers, describing price and capacity changes, with monthly panel data from June 2006 to October 2010.

4.1.1.1 Jeju-Seoul Route (r = 1)

Table 4.1 provides the average values of own-price elasticities, marginal costs, and Lerner indices (%), $\frac{\left(p^r_{jt} - mc^r_{jt}\right)}{p^r_{jt}} \times 100$, for the main competitors: the two legacy carriers, KAL and AAR, as well as LCCs (dependent LCCs and independent LCCs). Own-price elasticities are computed using estimates for the demand specification (IV regression with brand fixed effects and BLP type instruments) and demand side variables. Then, the markups predicted by a (i) SBNE and a (ii) MBNE are reported. Finally, under the assumption of static profit maximization in each time period marginal costs are implied from the estimated markups. All values mentioned are weighted by sales (market share).[3] Table 4.2 presents average values of capacity variables, number of daily flights, aircraft fleet size, load factor, and market share for the main competitors: two legacy carriers, KAL and AAR, and LCCs (dependent LCCs and independent LCCs).[4]

[3]For each row, the average of the time varying market share weighted average values within the carrier are reported other than the values in the independent LCC row. For the independent LCCs, the average of the time varying market share weighted average values across different independent LCCs are presented.

[4]The outside good market shares calculated from 0.01% to 0.5% of populations for origin cities flying to Jeju island range between 0.164% and 8.211% for the Jeju-Seoul route. The demand estimation results are qualitatively insensitive to the choice of time- and route-specific outside goods, at 0.01% to 0.5% of population for origin cities. In our context, the chapter 4 will proceed with the chosen percentage (0.1%) of populations for origin cities.

In the presence of the outside good, the market share for the inside good does not add up to 100%. This also applies to the rest of the routes.

Table 4.1: Own price elasticities, marginal costs, and Lerner indices: Pre- and post-deregulation for the Jeju-Seoul route (r = 1)

1. Jeju-Seoul route		Pre-deregulation				Post-deregulation			
Supply model	Airline	Fare (US $)	Own price elasticities	MC (US $)	Lerner index	Fare (US $)	Own price elasticities	MC (US $)	Lerner index
(i) Single-product Bertrand competition	KAL (Legacy carrier)	75.36	-2.047	38.38	49.11%	76.24	-3.013	50.75	33.49%
	JNA (Dependent LCC)	N/A				61.25	-3.566	44.02	28.27%
	AAR (Legacy carrier)	75.36	-3.441	53.45	29.18%	76.14	-3.685	55.44	27.30%
	ABL (Dependent LCC)	N/A				N/A			
	Independent LCCs	55.07	-3.362	38.62	29.95%	61.59	-3.542	44.17	28.48%
(ii) Multi-product Bertrand competition	KAL (Legacy carrier)	75.36	-2.047	38.38	49.11%	76.24	-3.013	45.40	40.64%
	JNA (Dependent LCC)	N/A				61.25	-3.566	30.48	50.38%
	AAR (Legacy carrier)	75.36	-3.441	53.45	29.18%	76.14	-3.685	55.44	27.30%
	ABL (Dependent LCC)	N/A				N/A			
	Independent LCCs	55.07	-3.362	38.62	29.95%	61.59	-3.542	44.17	28.48%

Table 4.2: Capacity change: Pre- and post-deregulation for the Jeju-Seoul route (r = 1)

1. Jeju-Seoul route		Pre-deregulation				Post-deregulation			
Supply model	Airline	Number of daily flights	Aircraft size	Load factor	Market share	Number of daily flights	Aircraft size	Load factor	Market share
(i) Single-product Bertrand competition	KAL (Legacy carrier)	25.7	261	0.806	0.573	23.4	261	0.745	0.388
	JNA (Dependent LCC)	N/A				10.0	189	0.685	0.112
	AAR (Legacy carrier)	19.8	169	0.837	0.298	21.3	171	0.827	0.257
	ABL (Dependent LCC)	N/A				N/A			
	Independent LCCs	10.7	78	0.792	0.102	12.5	148	0.780	0.225
(ii) Multi-product Bertrand competition	KAL (Legacy carrier)	25.7	261	0.806	0.573	23.4	261	0.745	0.388
	JNA (Dependent LCC)	N/A				10.0	189	0.685	0.112
	AAR (Legacy carrier)	19.8	169	0.837	0.298	21.3	171	0.827	0.257
	ABL (Dependent LCC)	N/A				N/A			
	Independent LCCs	10.7	78	0.792	0.102	12.5	148	0.780	0.225

Fare variables used in the data sets are deflated by the 2005 Consumer Price Index (CPI). All estimated own-price elasticities are negative and in a range between -2.047 and -3.685. In both periods, the flight demands for KAL are characterized as less elastic (the average own-price elasticity was -2.047 in the regulated period and -3.013 in the deregulated period) than the rest of the competitors, including AAR and independent LCCs.

First, let us analyze the two legacy carries in the pre-deregulation period. Comparing the two major airlines, KAL reached a 57.3% market share in the regulated period when both major airlines charged the same ticket price, which was almost twice as high as the share of its main rival, AAR. Regarding capacity, KAL's flights were scheduled 30% more frequently than AAR, also operating larger aircraft with 261 seats each. The larger passenger volume for KAL was accommodated with larger aircraft, more frequent flights, and an 80.6% average load factor. The implied short run economic marginal cost for KAL flights was lower than the rest, including independent LCC competitors. The average Lerner indices for KAL were 49.1%, predicted by a (i) SBNE and would be consistent with a lower cost per passenger for KAL.

In the pre-deregulation period, few independent LCCs were serving the Jeju-Seoul route, but most of these were non-scheduled air service carriers subject to the regulated market policies. These carriers were only allowed to operate aircraft with fewer than 80 available seats and with restrictions on the age of the plane (requiring less than a 25-year age limit for each aircraft). These restrictions on non-scheduled air service carriers greatly limited aircraft availability and selection, forcing the carriers to use only small turbo-prop aircraft. Independent LCCs offered tickets at 73% of the air fares charged by the two legacy carriers, yet in spite of their low fares and a 79% average load factor, the independent LCCs only reached a 10% market share, operating small-sized aircraft with a limited number of seats (i.e., 78 seats) per plane. The average Lerner indices for independent LCCs predicted by (i) SBNE was 30%. Moreover, the implied marginal costs were in a reasonable order of magnitude for all flights.

The most striking findings here are the consequences of the May 2008 Deregulation Act. Competition in the Jeju-Seoul route, dominated by KAL and AAR, has intensified since deregulation as new independent LCCs have entered the market. As the number of carriers on the route increased, the average operating profits of each carrier decreased, each having fewer passengers.

With regard to independent LCCs in the post-deregulation period, restrictions imposed on aircraft size for the non-scheduled airlines were eliminated so that even independent LCCs were able to operate jet aircraft with more than 100 seats per airplane. The deregulation helped independent LCCs reach a 22.5% market share. Still, no significant change has occurred in the indices of the independent LCCs. The average Lerner indices for independent LCCs slightly decreased compared with those of the pre-deregulation period.

The divergent responses by the two legacy carriers were implemented in the deregulated period. Asiana Air maintained its legacy carrier service under the AAR badge with a similar level of flight frequency and aircraft size as before. The analysis of multiproduct firm activity does not apply to AAR, with only one variety of airline service on the Jeju-Seoul route. Consequently the average Lerner indices predicted by both a (i) SBNE and a (ii) MBNE had the identical value of 25.7%, which were 1.8% lower than that of pre-deregulation.

In contrast, KAL's joint ownership with start-up subsidiary JNA resulted in a successful strategic response to the independent LCCs' competition. Korean Air charged different ticket prices for its KAL and JNA brands. Taking into account the fact that most LCC customers are sensitive to price, JNA fliers were charged the same low price the independent LCCs offered. On the other hand, KAL fliers were charged almost the same price as were AAR fliers. KAL as a single entity operated both KAL flights and JNA flights, expanding total daily flights to 33, which exceeded its pre-deregulation flight frequency by 20.6%. KAL took 38.8% of the market share under the KAL badge alone while holding a fixed fleet size. JNA recorded an 11.2% market share, operating larger jet aircraft than both AAR and all independent LCCs. Korean Air reached a total market share of 50% through its multi-brand (two brands) strategies between July 2008 and October 2010. Compared with its pre-deregulation market share of 57.3%, the post-deregulation market share decreased by 18.5% for the KAL badge alone, but only decreased by 7.3% for the two brands - KAL and JNA - operation.

Regarding the multi-brand strategies of Korean Air in the deregulated period, the average values for marginal cost, which are predicted by non-cooperative oligopoly equilibrium in the two different static Bertrand competition models, show distinct results across models. Compared with a SBNE (eq(7)), a MBNE (jointly solving eq(8) and eq(9)) predicts a lower marginal cost for both KAL flights and JNA flights. As a consequence, a (ii) MBNE exhibits a larger number for the Lerner indices for each brand (KAL flights and JNA flights) of Korean Air than in the alternative SBNE model. For KAL flights, the average Lerner index predicted by a (ii) MBNE, 40.6%, was higher than 33.5% of a (i) SBNE in the post-deregulation period. For JNA flights, the average Lerner index predicted by a (ii) MBNE, 50.4%, was higher than 28.7% of a (i) SBNE. These huge gaps between models, particularly for JNA flights, could be attributed to the multiproduct firm-specific markup term in the pricing equations (8) and (9). It can be interpreted as strong evidence for Korean Air's intense multiproduct activity. However, the potential problem in interpreting the results from the MBNE may arise from the way in which the diversion ratio, a critical component of the firm-specific term in the equations (8) and (9), is constructed.

Table 4.3 and 4.4 illustrate how the MBNE predicts the price-cost margins for KAL flights and JNA flights based on diversion ratios taking into account the cross product effects between varieties offered by the same firm, Korean Air, in the Jeju-Seoul route from two perspectives: Before and after the entry of JNA in July 2008 on the Jeju-Seoul route.[5]

[5] In the presence of the outside good option, the diversion ratios in response to a rise in price do not add up to 100%.

Table 4.3: Illustration of diversion from KAL as a result of a 1% price increase: Jeju-Seoul route (r = 1)

Jeju-Seoul route: June 2006 - June 2008

Price change in KAL		Diversion to						
Airline	KAL	AAR	JNA	ONA	HAN	JJA	ESR	TWB
	Legacy carrier	Legacy carrier	Dependent LCC	Independent LCC				
Market share	0.571	0.299	N/A	N/A	0.029	0.079	N/A	N/A
Diversion ratio		73.71%	N/A	N/A	6.75%	19.14%	N/A	N/A

Jeju-Seoul route: July 2008 - October 2010

Price change in KAL		Diversion to						
Airline	KAL	AAR	JNA	ONA	HAN	JJA	ESR	TWB
	Legacy carrier	Legacy carrier	Dependent LCC	Independent LCC				
Market share	0.383	0.254	0.112	0.004+	0.045+	0.118	0.130	0.036
Diversion ratio		43.37%	18.14%	0.76%	8.96%	19.91%	20.43%	5.39%

+The two independent LCCs ceased operations in November (HAN) and in December (ONA) 2008.

Table 4.4: Illustration of diversion from JNA as a result of a 1% price increase: Jeju-Seoul route (r = 1)

Jeju-Seoul route: July 2008 - October 2010

Price change in JNA		Diversion to						
Airline	JNA	KAL	AAR	ONA	HAN	JJA	ESR	TWB
	KAL's subsidiary LCC	Legacy carrier	Legacy carrier	Independent LCC				
Market share	0.112	0.383	0.254	0.004+	0.045+	0.118	0.130	0.036
Diversion ratio		43.81%	29.06%	0.08%	0.69%	13.59%	11.90%	0.31%

+The two independent LCCs ceased operations in November (HAN) and in December (ONA) 2008.

Table 4.3 demonstrates a substitution pattern among flights as a result of a rise in price for KAL flights, say 1%, based upon the demand estimates (chapter 2) and cross price elasticities.[6] As seen in Table 4.3, the lost sales for KAL flights following an increase in prices for KAL flights are partly captured by JNA flights, compensating for the lost sales of KAL flights. From June 2006 through June 2008, each numeric value for the diversion ratio in the

[6]See appendix Table 16 for the carrier-specific average price elasticities.

fourth row in the first part of Table 4.3 represents the proportion of fliers who would switch to which of the other carriers. For example, the diversion ratio to AAR is 73.3%, meaning 73 fliers who initially purchased KAL tickets would choose AAR as a second choice. In the same way, the diversion ratio to Hansung Air (HAN) is just 6.7%, meaning at most 7 fliers who initially flew KAL would choose HAN as a second choice. The diversion ratio to a Jeju Air (JJA) flight is 19.1%, meaning 19 fliers who initially chose KAL would switch to JJA. The largest diversion ratio shown in the table indicates that AAR would be the closest substitute for KAL.

As described in Table 4.3 from July 2008 to October 2010 in the presence of JNA, the diversion ratio from KAL to JNA is 18.1%, indicating that 18% of KAL's lost sales induced by its price increases would be diverted to JNA. Still, AAR, based on the diversion ratio, would be the closest substitute for KAL, capturing 43.3% of KAL's lost sales. Even though JNA is not the closest substitute for KAL, it would be effectively as competitive as the two surviving independent LCCs, at 19.9% for JJA and 20.4% for Eastar Jet (ESR), and would be a more competitive carrier than either HAN or ONA, which ceased their operations in 2008. Thus, the lost sales for KAL flights are partly captured by JNA flights under the MBNE (40.6% in (ii) MBNE in Table 4.1) while those are not under the SBNE (33.5% (i) SBNE in Table 4.1).

The results presented in Table 4.4 clearly show that the diversion ratios play an important role in predicting high Lerner indices (50.4% in (ii) MBNE Table 4.1 vs 28.3% in (i) SBNE Table 4.1) for JNA flights. In the similar manner for interpreting the results in Table 4.3, Table 4.4 reports a substitution pattern among flights as a result of a rise in price for JNA flights, say 1%, based on the econometric results (chapter 2) and the estimated cross price elasticities. From July 2008 to October 2010 in the presence of JNA, the diversion ratio to KAL, its parent company, is 43.8%, indicating that 44% of JNA's lost sales induced by its price increases would be diverted to KAL. The largest diversion ratio, shown in the table, indicates that KAL flights would be the closest substitute for JNA flights, thus attaining greater market power in a highly concentrated route. The diversion ratio to AAR is 29%, meaning 29 fliers who initially chose JNA would switch to AAR. As mentioned earlier, the diversion ratios based on the nested logit demand structure can be potentially problematic. In the nested logit demand model average cross-price elasticities are mainly derived by the observed market shares of each carrier, not by the similarity between flight characteristics across carriers. Given that a diversion ratio is designed to put more weight on a carrier having a larger market share, and KAL recorded the largest market share, the MBNE predicts that JNA's lost sales would divert toward KAL rather than to independent LCCs. This is surprising, because one may think that JNA, a subsidiary LCC unit, would be competitive against other LCCs. Therefore, the huge markups for JNA flights predicted by the MBNE should be interpreted as an upper bound.

As opposed to the two legacy carriers, the two independent LCC survivors which have established themselves in the Jeju-Seoul route, JJA and ESR, have relatively low diversion ratios at 13.6% for JJA and 11.9% for ESR. For the other three independent LCCs, ONA, HAN, and TWB, no substantial amounts of diversion are reported.

4.1.1.2 Jeju-Busan Route (r = 2)

Table 4.5 provides the average values of own-price elasticities, marginal costs, and Lerner indices (%), $\frac{(p^r_{jt} - mc^r_{jt})}{p^r_{jt}} \times 100$, for the main competitors: the two legacy carriers, KAL and AAR, as well as LCCs (dependent LCCs and independent LCCs). Own-price elasticities are computed using estimates of the demand specification (IV regression with brand fixed effects and BLP type instruments) and demand side variables. Then, the markups predicted by a (i) SBNE and a (ii) MBNE are reported. Finally, under the assumption of static profit maximization in each time period marginal costs are implied from the estimated markups. All values mentioned are weighted by sales (market shares). Table 4.6 presents average values of capacity variables, number of daily flights, aircraft fleet size, load factor, and market share for the main competitors: two legacy carriers, KAL and AAR, and LCCs (dependent LCCs and independent LCCs).[7]

Table 4.5: Own price elasticities, marginal costs, and Lerner indices: Pre- and post-deregulation for the Jeju-Busan route (r = 2)

2. Jeju-Busan route		Pre-deregulation				Post-deregulation			
Supply model	Airline	Fare (US $)	Own price elasticities	MC (US $)	Lerner index	Fare (US $)	Own price elasticities	MC (US $)	Lerner index
(i) Single-product	KAL (Legacy carrier)	58.38	-1.364	15.18	74.08%	60.02	-2.286	33.10	44.87%
Bertrand competition	JNA (Dependent LCC)		N/A			JNA presence Apr 2009 - Dec 2009			
						44.45	-2.741	28.22	36.53%
	AAR (Legacy carrier)	57.96	-3.255	40.12	30.87%	AAR rebadged to ABL in Dec 2008.			
	ABL (Dependent LCC)		N/A			53.84	-2.605	33.00	38.77%
	Independent LCCs	43.10	-2.914	28.29	34.45%	48.90	-3.107	33.11	32.61%
(ii) Multi-product	KAL (Legacy carrier)	58.38	-1.364	15.18	74.08%	60.02	-2.286	30.64	49.22%
Bertrand competition	JNA (Dependent LCC)		N/A			JNA presence Apr 2009 - Dec 2009			
						44.45	-2.741	13.42	69.95%
	AAR (Legacy carrier)	57.96	-3.255	40.12	30.87%	AAR rebadged to ABL in Dec 2008.			
	ABL (Dependent LCC)		N/A			53.84	-2.605	33.00	38.77%
	Independent LCCs	43.10	-2.914	28.29	34.45%	48.90	-3.107	33.11	32.61%

[7] The outside good market shares calculated from 0.01% to 0.5% of populations for origin cities flying to Jeju island range between 0.233% and 11.627% for the Jeju-Busan route.

Table 4.6: Capacity change: Pre- and post-deregulation for the Jeju-Busan route (r = 2)

2. Jeju-Busan route		Pre-deregulation				Post-deregulation			
Supply model	Airline	Number of daily flights	Aircraft size	Load factor	Market share	Number of daily flights	Aircraft size	Load factor	Market share
(i) Single-product	KAL (Legacy carrier)	10.2	227	0.715	0.678	7.9	242	0.703	0.477
Bertrand competition	JNA (Dependent LCC)	N/A				JNA presence Apr 2009 - Dec 2009 4.0	189	0.666	0.163
	AAR (Legacy carrier)	4.7	158	0.780	0.237	AAR rebadged to ABL in Dec 2008.			
	ABL (Dependent LCC)	N/A				8.8	134	0.873	0.342
	Independent LCCs	3.1	78	0.843	0.083	3.7	130	0.849	0.144
(ii) Multi-product	KAL (Legacy carrier)	10.2	227	0.715	0.678	7.9	242	0.703	0.477
Bertrand competition	JNA (Dependent LCC)	N/A				JNA presence Apr 2009 - Dec 2009 4.0	189	0.666	0.163
	AAR (Legacy carrier)	4.7	158	0.780	0.237	AAR rebadged to ABL in Dec 2008.			
	ABL (Dependent LCC)	N/A				8.8	134	0.873	0.342
	Independent LCCs	3.1	78	0.843	0.083	3.7	130	0.849	0.144

Fare variables used in the data set are deflated by the 2005 Consumer Price Index (CPI). All estimated own-price elasticities are negative and in a range between -1.364 and -3.255. Similar to the Jeju-Seoul route, the flight demands for KAL are characterized as less elastic (the average own-price elasticity was -1.364 in the regulated period and -2.286 in the deregulated period) than the rest of the competitors, including AAR and LCCs in both periods. KAL reached a 67.8% market share in the regulated period when both major airlines charged similar ticket price levels, which was almost three times higher than that of its main rival, AAR. The larger market share was accommodated with larger aircraft, more frequent flights, and 71.5% average passenger load factors. KAL had twice the flight frequency of AAR, and it also operating large-sized aircraft with 227 seats each. The average Lerner indices for KAL predicted by a (i) SBNE was 78.1%. The low marginal costs and huge market shares would support high Lerner indices for KAL.

One independent LCC, JJA, flying the Jeju-Busan route before May 2008, operated turbo-prop aircraft with fewer than 80 available seats per plane, offering tickets at 80% of the air fares charged by the two legacy carriers. Despite low air fares and a sufficiently high average load factor of 84.3%, the independent LCC only recorded an 8.3% market share, scheduling three daily flights and operating small-sized aircraft with a limited number of seats (i.e., 78 seats) per plane. The implied marginal costs are within a reasonable order of magnitude for all flights. The average Lerner indices for the independent LCC predicted by a (i) SBNE was 34.4%.

The May 2008 Deregulation Act removed restrictions imposed on aircraft size for the non-scheduled airlines; thus, all independent LCCs were then able to operate jet aircraft with more than 100 seats each. As a result, independent LCCs reached a 14.4% market share, which exceeded their pre-deregulation market share by 6.1%. The average Lerner indices for independent LCCs rather decreased. One possible explanation for this may stem from the introduction of fuel surcharges. The independent LCCs charged almost the same amount of fuel surcharges as those of the two legacy carriers. As a consequence, the average prices for the independent LCCs increased by the greatest amount of 13.5% since July 2008 and those for KAL only increased by 2.8% over the same time period. Finally, ONA only flew the Jeju-Busan route for five months and ceased operations in December 2008 at a time of unexpectedly high fuel prices.

The two legacy carriers have diversified their strategies in the post-deregulation period, when they faced competition from the independent LCCs. While AAR operated under the AAR brand alone in the Jeju-Seoul route, it responded with its own subsidiary LCC, ABL, in the Jeju-Busan route. This joint ownership strategy between AAR and ABL was a competitive response to KAL as well as independent LCCs. Extending its reputation through the code-share operation with ABL created customer loyalty, sharing the online reservation system for airline tickets. In other words, AAR rebadged to ABL and charged air fare 10.3% higher than the competing independent LCCs, but 10.10% lower than KAL, which may have been able to draw fliers off from the latter. There was strong evidence that AAR increased capacity on the Jeju-Busan route right after its rebadging strategy. ABL scheduled a total of

8.8 daily flights, which exceeded its pre-deregulation flight frequency under AAR operation by 87.2%. From December 2008 to October 2010 ABL reached a 34.2% market share while decreasing its aircraft size from 158 seats to 135 seats per airplane. This number exceeded its market share of 23.7% under AAR operation in the regulated period. The AAR's rebadging strategy, i.e., replacing its prior service with ABL, does not constitute a new entry. Therefore analysis on the multiproduct firm activity does not apply to AAR. Consequently the average Lerner indices predicted by both a (i) SBNE and a (ii) MBNE had the identical value of 38.8%, which was 7.9% greater than that of the pre-deregulation period.

On the other hand, KAL operated under both the KAL and JNA badges for only 9 months from April 2009 through November 2009. JNA charged air fare 10% lower than the competing independent LCCs and 21.1% lower than ABL. Korean Air scheduled 8 daily flights under the KAL badge and 4 daily flights under the JNA badge. With regard to capacity change, the total number of daily scheduled flights decreased from 10.2 in the pre-deregulation period to 7.9 (KAL badge alone) in the post-deregulation period. During the deregulation period (June 2008 through October 2010) KAL took 47.7% market share alone while increasing its fleet size up to 242 seats per airplane. Between April 2009 and November 2009 Korean Air reached a 16.3% market share under JNA badge, operating jet aircraft with 189 seats per airplane, and recorded a 64% total market share across the two brands. KAL's passenger volumes slightly fell in the post-deregulation period (it recorded 67% in the pre-deregulation period).

Regarding the multi-brand strategies of Korean Air in the deregulated period, the average values for marginal cost, which are predicted by non-cooperative oligopoly equilibrium in the two different static Bertrand competition models, show distinct results across models. Compared with a SBNE (eq(7)), a MBNE (jointly solving eq(8) and eq(9)) predicts a lower marginal cost for both KAL flights and JNA flights. As a consequence, a (ii) MBNE exhibits a larger number for the Lerner index for each brand (KAL flights and JNA flights) of Korean Air than in a (i) SBNE.

For KAL flights, the average Lerner index predicted by a (ii) MBNE, 49.2%, was higher than the 45% predicted by a (i) SBNE in the post-deregulation period. For JNA flights, the average Lerner index predicted by a (ii) MBNE, 70%, was higher than the 36.5% of a (i) SBNE. These huge gaps between models, particularly for JNA flights, could be attributed to the multiproduct firm-specific markup term in the pricing equations (8) and (9). It can be interpreted as strong evidence for Korean Air's intense multiproduct activity. However, the potential problem in interpreting the results from the MBNE may arise from the way in which the diversion ratio, a critical component of the firm-specific term in the equations (8) and (9), is constructed.

Tables 4.7 and 4.8 illustrate how the MBNE predicts the price-cost margins for KAL flights and JNA flights based on diversion ratios taking into account the cross product effects between varieties offered by the same firm, Korean Air, in the Jeju-Busan route from four perspectives: Pre-deregulation period, before and after JNA entry in April 2009, and after JNA exit in November 2009.[8] In July 2008, just two months after the May 2008 Deregulation Act, ONA entered in the Jeju-Busan route. From July to March 2009, ABL was the first dependent LCC in this route after AAR rebadged to ABL in December 2008. From April to November 2009 in the presence of JNA, JNA competed with not only the independent LCCs, but also the dependent LCC, ABL. After JNA ceased the Jeju-Busan route service in January 2010, ABL continued to fly the route as the sole representative dependent LCC.[9]

[8]In the presence of the outside good option, the diversion ratios in response to a rise in price do not add up to 100%.

[9]See appendix for the carrier-specific average price elasticities. The data point (December 2009) was excluded from the data analysis. In December 2009, the passengers flying each carrier data were missing at Korea Airports Corporation (KAC).

Table 4.7: Illustration of diversion from KAL as a result of a 1% price increase: Jeju-Busan route (r = 2)

Jeju-Busan route: June 2006 - June 2008

Price change in KAL		Diversion to				
Airline	KAL	AAR	ABL	JNA	ONA	JJA
	Legacy carrier	Legacy carrier	Dependent LCC	Dependent LCC	Independent LCC	
Market share	0.677	0.237	N/A	N/A	N/A	0.083
Diversion ratio		75.39%	N/A	N/A	N/A	26.10%

Jeju-Busan route: July 2008 - March 2009

Price change in KAL		Diversion to				
Airline	KAL	AAR	ABL	JNA	ONA	JJA
	Legacy carrier	Legacy carrier	Dependent LCC	Dependent LCC	Independent LCC	
Market share	0.579	Rebadged to ABL	0.261	N/A	0.017+	0.142
Diversion ratio		N/A	63.15%	N/A	4.21%	34.04%

+ONA ceased operation in December 2008.

Jeju-Busan route: April 2009 - November 2009

Price change in KAL		Diversion to				
Airline	KAL	AAR	ABL	JNA	ONA	JJA
	Legacy carrier	Legacy carrier	Dependent LCC	Dependent LCC	Independent LCC	
Market share	0.391	Rebadged to ABL	0.314	0.163+	N/A	0.124
Diversion ratio		N/A	51.76%	27.29%	N/A	20.70%

+JNA ceased the Jeju-Busan route service in January 2010.

Jeju-Busan route: January 2010 - October 2010

Price change in KAL		Diversion to				
Airline	KAL	AAR	ABL	JNA	ONA	JJA
	Legacy carrier	Legacy carrier	Dependent LCC	Dependent LCC	Independent LCC	
Market share	0.436	Rebadged to ABL	0.398	N/A	N/A	0.160
Diversion ratio		N/A	71.24%	N/A	N/A	28.52%

Table 4.8: Illustration of diversion from JNA as a result of a 1% price increase: Jeju-Busan route (r = 2)

Jeju-Busan route: April 2009 - November 2009

Price change in JNA		Diversion to				
Airline	JNA	KAL	AAR	ABL	ONA	JJA
	KAL's subsidiary LCC	Legacy carrier	Legacy carrier	Dependent LCC	Independent LCC	
Market share	0.163	0.391	Rebadged to ABL	0.314	N/A	0.124
Diversion ratio		47.11%	N/A	37.76%	N/A	14.96%

Table 4.7 illustrates a substitution pattern among flights as a result of a rise in price for KAL flights, say 1%, based upon the demand estimates (chapter 2) and cross price elasticities.[10] From June 2006 through June 2008 each numeric value in the fourth row in Table 4.7, represents the proportion of fliers who would switch to which of the two competing carriers, either AAR or JJA. For example, the diversion ratio to AAR is 75.4%, meaning that 75 fliers who initially purchased KAL tickets would choose AAR as opposed to JJA. In the same way, the diversion ratio to JJA is 26.1%, meaning 26 fliers who initially flew KAL would choose JJA as a second best choice.[11] The largest diversion ratio, shown in the table, indicates that AAR would be the closest substitute for KAL.

From July 2008 through March 2009, the diversion ratio to ABL is 63.1%, indicating that 63% of KAL's lost sales induced by its price increases would be diverted to ABL. Based on the diversion ratio, ABL is the closest substitute for KAL. The diversion ratio to JJA is 34%, meaning 34 fliers out of 100 who initially chose KAL would switch to JJA. Yeongnam Air (ONA) which only flew five months between July 2008 and November 2008 has a diversion ratio of only 4.2%.

In the presence of JNA (from April 2009 to November 2009), ABL still has the largest diversion ratio of 51.7%, implying that more than half of the lost sales from KAL's price increases would be diverted to ABL. The diversion ratio to JNA is 27.3%, meaning 27 fliers

[10]See appendix Table 17 for the carrier-specific average price elasticities.

[11]Diversion ratio does not sum to 100% since Jeju Air (JJA) launched flights between Jeju and Busan in Aug 2006.

out of 100 who initially chose KAL would switch to JNA as opposed to ABL or JJA. JJA has a diversion ratio of 20.7%, meaning 20 fliers who initially purchased KAL tickets would choose JJA as a second choice. The diversion ratios indicate that ABL would be the closest substitute for KAL and JNA would be more likely to compete with JJA rather than ABL.

After JNA stopped its Jeju-Busan route service, the market structure is similar to that of the pre-deregulation period. The diversion ratio to ABL is 71.2%, meaning 71 fliers who initially purchased KAL tickets would choose ABL over JJA. In the same way, the diversion ratio to JJA is 28.5%, meaning 28 fliers who initially flew KAL would choose JJA as a second choice.

The results reported in Table 4.8 provide the main source for a huge gap in JNA's Lerner indices across two models, 36.53% for SBNE and 69.95% for MBNE. Suppose 100 fewer fliers chose JNA when it raised air fares, say 1%. From April to November 2009, the diversion ratio to KAL is 47.1%, indicating that 47% of JNA's lost sales induced by its price increases would be captured by KAL. The largest diversion ratio indicates that KAL flights would be the closest substitutes for JNA flights, thus attaining greater market power across two brands. The diversion ratio to ABL is 37.8%, meaning 38 fliers who initially chose JNA would switch to ABL. Given that a diversion ratio is designed to put more weight on a carrier having a larger market share, and KAL recorded the largest market share, the MBNE predicts that JNA's lost sales divert toward KAL rather than to independent LCCs. Again, this is surprising because one may think that JNA, a subsidiary LCC unit, would compete against other LCCs. As opposed to the two legacy carriers, one independent LCC survivor, which has established in the Jeju-Busan route, JJA, has relatively low diversion ratios of 15%.

4.1.1.3 Jeju-Cheongju Route (r = 3)

On the Jeju-Cheongju route, two types of carriers competed with each other: Legacy carriers and independent LCCs. Neither KAL nor AAR responded with its own subsidiary LCC. The analysis of multiproduct firm activities does not apply to this route in which each carrier supplied its own flights under one brand.

Table 4.9 provides the average values of own-price elasticities, marginal costs, and Lerner indices (%), $\frac{\left(p^r_{jt}-mc^r_{jt}\right)}{p^r_{jt}} \times 100$, for the main competitors: the two legacy carriers, KAL and AAR, as well as independent LCCs. Own-price elasticities are computed using estimates for the demand specification (IV regression with brand fixed effects and BLP type instruments) and demand side variables. Then, the markups predicted by a (i) SBNE are reported. Finally, under the assumption of static profit maximization in each time period marginal costs are derived from the estimated markups. All values mentioned are weighted by sales (market shares).[12] Table 4.10 presents average values of capacity variables, number of daily flights, aircraft fleet size, load factor, and market share for the main competitors: two legacy carriers, KAL and AAR, and independent LCCs.[13]

[12] The estimated value of the nesting parameter σ_r is 0.508. Holding the other variables fixed, the smaller σ_r is, the less own-price elasticity η_{jj} is. For the Jeju-Cheongju route, the own-price elasticities for all flights are calculated in a range between -1.166 and -1.596.

[13] The outside good market shares calculated from 0.01% to 0.5% of populations for origin cities flying to Jeju island range between 0.006% and 3.192% for the Jeju-Cheongju route.

Table 4.9: Own price elasticities, marginal costs, and Lerner indices: Pre- and post-deregulation for the Jeju-Cheongju route (r = 3)

3. Jeju-Cheongju route		Pre-deregulation				Post-deregulation			
Supply model	Airline	Fare (US $)	Own price elasticities	MC (US $)	Lerner index	Fare (US $)	Own price elasticities	MC (US $)	Lerner index
(i) Single-product	KAL (Legacy carrier)	66.15	-1.166	9.45	85.88%	67.17	-1.328	16.34	76.15%
Bertrand competition	AAR (Legacy carrier)	66.15	-1.327	16.22	75.76%	67.08	-1.466	21.17	68.87%
	Dependent LCCs		N/A				N/A		
	Independent LCCs	56.06	-1.596	20.91	62.93%	54.64	-1.537	19.03	65.67%

Table 4.10: Capacity change: pre- and post-deregulation for the Jeju-Cheongju route (r = 3)

3. Jeju-Cheongju route		Pre-deregulation				Post-deregulation			
Supply model	Airline	Number of daily flights	Aircraft size	Load factor	Market share	Number of daily flights	Aircraft size	Load factor	Market share
(i) Single-product	KAL (Legacy carrier)	3.8	185	0.821	0.466	3.9	194	0.767	0.402
Bertrand competition	AAR (Legacy carrier)	3.9	168	0.739	0.394	3.8	178	0.721	0.339
	Dependent LCCs		N/A				N/A		
	Independent LCCs	3.2	72	0.742	0.140	2.5	121	0.760	0.259

Fare variables used in the data sets are deflated by the 2005 Consumer Price Index (CPI). All estimated own-price elasticities are negative and in a range between -1.166 and -1.596. Estimated own-price elasticities are lower in absolute value for flights having larger market shares. In both periods, the flight demand curves for KAL are characterized as less elastic (the average own-price elasticity was -1.166 in the regulated period and -1.328 in the deregulated period) than for the rest of the competitors including AAR and independent LCCs.

In contrast to the previously analyzed other two Jeju island routes, KAL and AAR were almost equally dominant carriers in the Jeju-Cheongju route. KAL reached a 46.6% market share in the regulated period when both major airlines charged the same ticket price, which was just 7.2% higher than that of its main rival, AAR. Regarding capacity, KAL scheduled 3.8 daily flights, operating larger aircraft with 185 seats each. The larger passenger volume for KAL was accommodated with larger aircraft and 82.1% average load factors. The implied short run economic marginal cost for KAL flights was lower than the rest, including independent LCC competitors. The average Lerner index for KAL was 85.9% under a (i) SBNE. This would be consistent with a lower cost per passenger for KAL. AAR scheduled 3.9 daily flights with 168 seats per airplane. With 73.9% average load factors, which were 8% lower than KAL, AAR was the second largest carrier by market share. The average Lerner index for AAR was 75.7% under a (i) SBNE.

One independent LCC, HAN, was flying the Jeju-Cheongju route before May 2008, but it ceased operations in November 2008. HAN operated turbo-prop aircraft with 78 seats per plane, offering tickets at 84.7% of the air fares charged by the two legacy carriers. Despite the low air fares and average load factor of 74.2%, HAN only recorded a 14% market share, scheduling three flights a day, which were almost the same frequency on the legacy carriers. The implied marginal costs are within a reasonable order of magnitude for all flights. The average Lerner index for the independent LCC predicted by a (i) SBNE was 62.9%.

The most striking findings here are the consequences of the May 2008 Deregulation Act. Competition in the Jeju-Cheongju route, dominated by KAL and AAR, has intensified since deregulation. New independent LCCs with price competitiveness have entered the market. In the deregulated period when each carrier started to impose fuel surcharges on all domestic flights, the average prices for independent LCCs rather fell to \$54.4, implying that two independent LCCs, JJA and ESR, had price competitiveness. Furthermore, the restrictions imposed on aircraft size for the non-scheduled airlines were eliminated so that all independent LCCs were able to operate jet aircraft with more than 100 seats per airplane. This caused the average aircraft size for the independent LCCs to increase up to 121 seats per airplane. Along with its increased fleet size, average load factors of 76% helped the independent LCCs reach a 25.9% market share. The average Lerner indices for the independent LCCs predicted by a (i) SBNE was 65.7%, which exceeded the Lerner index of that of 62.9%.

In response to the intensified competition from newly sprouting independent LCCs, KAL and AAR maintained their pre-deregulation strategies. Korean Air operated under the KAL badge alone and Asiana Air also operated under the AAR badge alone. For both legacy carriers, the average flight frequencies and aircraft size were kept at their pre-deregulation levels. The average Lerner index predicted by a (i) SBNE decreased to 76.1% for KAL. Similarly, for AAR flights the average Lerner index predicted by a (i) SBNE decreased to 68.9%.

4.1.2 An Inland Route: Seoul-Busan

Within inland routes, air travel demands for two routes (r = 6, 7) are estimated, respectively: Seoul-Busan (r = 6) and Seoul-Gwangju (r = 7). The Seoul-Gwangju route has only been operated by the two legacy carriers, KAL and AAR. The strategies for the two legacy carriers that involve responding with subsidiary LCCs are limited to the Seoul-Busan (r = 6) route where Korean Air operated under two brands, KAL and JNA, and AAR replaced its prior operation with ABL. However, KAL only flew under a two brands strategy for three months between Jan 2009 and Mar 2009. In this context, I limit the main focus to the SBNE rather than the MBNE. I provide tables, describing their price and capacity strategies, with monthly panel data from June 2006 to October 2010.

4.1.2.1 Seoul-Busan Route (r = 6)

As seen in chapter 3 (section 3.1), we assume that our data reflect firms competing in short run (period by period) Nash equilibria and our (nested logit) demand structure reflects consumer behavior. That is, our maintained hypotheses include the assumption of short run Nash equilibria and nested logit demand.

From the maintained hypothesis of nested logit demand we can find firm level demand elasticities in each time period. With firm level demand elasticities and the maintained hypothesis of short run Nash equilibria along with the data on price and the demand elasticities we can solve for the price markup over marginal costs, which means we can solve for the level of marginal costs under these assumptions.

Following the methodology for reporting results for the Jeju island routes, Table 4.11 would report the average values of own price elasticities and computed markups, marginal costs and Lerner indices, $\frac{(p^r_{jt} - mc^r_{jt})}{p^r_{jt}} \times 100$, for all airlines, both pre and post deregulation. But there appears to be a failure in one of the two maintained hypotheses, either the nested logit or the short run profit maximization assumptions.

For the pre-deregulation time period for KAL flights the point estimates are inconsistent with the maintained hypotheses of nested logit demand and short run profit maximizing behavior for KAL. For this period KAL's estimated demand elasticity is less than 1 (in absolute size) which is inconsistent with short run profit maximization, so (at least) one of the maintained hypotheses fails.[14] The more likely possibility is that the nested logit does not adequately capture the true demand curve/elasticity for this airline and time period.

Why might the nested logit model fail for KAL flights and this time period? One property of nested logits tends to become less realistic in "one sided" demand scenarios, e.g., where one good dominates in demand. Probably this is related to the functional form for the demand estimation based on nested logit.[15] Under the nested logit specification demand elasticities are proportional to either price, p^r_{jt}, or market share through $\frac{\left(1-\sigma_r s_{jt/gt}-(1-\sigma_r)s_{jt}\right)}{1-\sigma_r}$. In Seoul-Busan route KAL had a dominant market share of around 80% in the pre-deregulation period. KAL's dominant market share may force its own-price elasticities to be small,[16] even less

[14]The estimated elasticity less than one is inconsistent with the maintained hypotheses. The high market share may have led to an inconsistency with the maintained hypothesis of nested-logit demand. It is also possible that nested logit is appropriate but the maintained hypothesis of shortrun profit maximization is violated. Or alternatively, both the nested logit and the shortrun profit maximization maintained hypotheses are valid, but simple statistical error has led to a point estimate of elasticity which is less than one. To examine this possibility we need to ask if the estimates are consistent with the possibility of elastic demand.

Statistically, our regressions estimate $\hat{\alpha} = 0.0816$, the coefficient on fare. An $\alpha_{\eta=1} = 0.1039$ is consistent with an elasticity, η_{jj}, equal to one. Given our estimate of 0.0816 with a standard error of 0.0147 the t-value for the difference (0.0223 = 0.1039-0.0816) is 1.5165 which is consistent with an elasticity greater than one with probability of at least 0.1292. Accordingly our estimates are consistent with the maintained hypothesis of shortrun profit maximization at this probability level.

[15]As seen in chapter 2, the nested logit demand structure specification is finished with an outside good. By construction, in the current framework, the relative prices and flight characteristics, such as flight frequency, aircraft size and other factors, determine the probabilities of choosing a flight $j = 0, 1, ..., J$.

Holding the estimated parameter values for α and $0 < \sigma_r < 1$, and prices unchanged (from the preferred demand specification using the Hausman instruments only, $\alpha = 0.0816$ and $\sigma_r = 0.869$ are estimated), the formula for the own-price elasticity of flight j, $\eta^r_{jj,t} = \left|\frac{p^r_{jt}}{s_{jt}}\frac{\partial s_{jt}}{\partial p^r_{jt}}\right| = \left|-\frac{\alpha}{1-\sigma_r}p^r_{jt}\left(1-\sigma_r s_{jt/gt}-(1-\sigma_r)s_{jt}\right)\right|$, would imply that a sufficiently large market share for a firm's flight j (compared with small size of the market share for the outside good in the current specification) may produce an own-price elasticity less than 1.

[16]See Petrin [2002]. The bias in the demand estimates due to a positive correlation of prices and unobserved product qualities could lead to spurious estimates of inelastic demand. Byproducts of the low estimated demand elasticities under OLS and instrumental variables include negative marginal costs when marginal costs are implied by demand side estimates.

The potential sources of the bias in the demand estimates in our context, in the Seoul-Busan route, may arise from the assumptions imposed on the demand taste parameter in chapter 2: Individual consumer i has the same coefficients for price and flight characteristics within the nest. This means the consumer's specific taste paramthan 1 (in absolute size) which implies the estimated negative marginal costs over the same time periods.[17] After ABL was launched and started to fly the route in the post-deregulation period, KAL partially lost their passengers to ABL and KAL's market share dropped to 65% with the estimated demand elasticities greater than 1 (in absolute size). Thus, the estimation results for this route, at least before-deregulation period, would be inconsistent with the static profit maximizing firm assumption. In this context, I will not focus on the Lerner indices for the KAL flights in the pre-deregulation period.[18]

Despite being unable to fully follow the reporting methodology used for the Jeju routes above, for comparability I report the rest of the results for Seoul-Busan in the same format as the above to at least describe parts of the behavior of the various airlines over this period. In Table 4.11 Own-price elasticities are computed using the estimates for the demand specification (IV regression with brand fixed effects and Hausman panel type instruments) and demand side variables. Then, the implied markups predicted by a (i) SBNE for the airline carriers and time periods with estimated demand elasticities greater than one are reported. Finally, marginal costs are implied from the estimated markups. All of the values are weighted by sales (market shares). Table 4.12 presents the average values of capacity variables, number of daily flights, aircraft fleet size, load factor, and market share for the main competitors: the two legacy carriers, KAL and AAR, and LCCs (dependent LCCs and independent LCCs).[19]

eters for price, $\alpha_i = \alpha$, and for flight attributes, $\beta_i = \beta$, are written as invariant across consumers, $i = 1, \ldots\ldots, I$, conditional upon the decision to fly. Air passengers who choose the KAL flights may have strong preference for the KAL flights, and these carrier specific unobserved quality or brand reputations could be possibly correlated to prices, causing the point estimate to drop. Or these demand taste parameters can significantly change from time to time, e.g., across pre- and post-deregulation, as opposed to current assumption, common parameters across times within the route.

[17]For a single product firm, the inelastic demand (demand elasticity less than 1) would imply the margin $(p^r_{jt} - mc^r_{jt}) > p^r_{jt}$ or $mc^r_{jt} < 0$ by pricing equation (7).

$\left|\eta^r_{jj,t}\right|$ is less than 1 which implies the margin $(p^r_{jt} - mc^r_{jt}) > p^r_{jt}$ or $mc^r_{jt} < 0$, which is inconsistent with the short run profit maximization assumption.

[18]The KAL flights in both a SBNE and a MBNE in post-deregulation column Tables 4.11 and 4.12 report the average values in the periods post January 2009.

[19]The outside good market shares calculated from 0.01% to 0.5% of populations for origin cities flying inland range between 0.171% and 8.544% for the Seoul-Busan route.

Table 4.11: Own price elasticities, marginal costs, and Lerner indices: Pre- and post-deregulation for the Seoul-Busan route (r = 6)

6. Seoul-Busan route		Pre-deregulation				Post-deregulation			
Supply model	Airline	Fare (US $)	Own price elasticities	MC (US $)	Lerner index	Fare (US $)	Own price elasticities	MC (US $)	Lerner index
(i) Single-product Bertrand competition	KAL (Legacy carrier)	63.96	-0.806	N/A	N/A	65.40	-1.397	18.74	70.73%
	AAR (Legacy carrier)	63.50	-3.264	44.04	30.73%	AAR rebadged to ABL in Oct 2008.			
	JNA (Dependent LCC)	N/A				JNA presence Jan 2009 - Mar 2009 49.89	-3.083	33.71	32.43%
	ABL (Dependent LCC)	N/A				55.95	-2.317	31.09	44.72%
	JJA (Independent LCC)	50.98	-3.210	35.11	31.25%	N/A			
(ii) Multi-product Bertrand competition	KAL and JNA	63.96	-0.806	N/A	N/A	65.35	-1.406	19.48	69.53%
	AAR and ABL	63.50	-3.264	44.04	30.73%	58.68	-2.520	34.50	42.21%
	JJA (Independent LCC)	50.98	-3.210	35.11	31.25%	N/A			

Table 4.12: Capacity change: Pre- and post-deregulation for the Seoul-Busan route (r = 6)

6. Seoul-Busan route		Pre-deregulation				Post-deregulation			
Supply model	Airline	Number of daily flights	Aircraft size	Load factor	Market share	Number of daily flights	Aircraft size	Load factor	Market share
(i) Single-product Bertrand competition	KAL (Legacy carrier)	21.2	180	0.776	0.796	16.9	182	0.699	0.654
	AAR (Legacy carrier)	8.2	160	0.542	0.191	AAR rebadged to ABL in Oct 2008.			
	JNA (Dependent LCC)	N/A				JNA presence Jan 2009 - Mar 2009 3.0	189	0.154	0.029
	ABL (Dependent LCC)	N/A				12.8	141	0.621	0.349
	JJA (Independent LCC)	2.2	78	0.241	0.011	N/A			
(ii) Multi-product Bertrand competition	KAL and JNA	21.2	180	0.776	0.796	17.3	182	0.697	0.657
	AAR and ABL	8.2	160	0.542	0.191	12.3	145	0.600	0.333
	JJA (Independent LCC)	2.2	78	0.241	0.011	N/A			

Fare variables used in the data sets are deflated by the 2005 Consumer Price Index (CPI). The estimated own-price elasticities for AAR and JJA are negative and in a range between -3.210 and -3.264 in the pre-deregulation period.[20] The estimated own-price elasticities for all flights are -1.397 and -3.083 in the post-deregulation period.[21]

[20]In Seoul-Busan route JJA had an 1.1% market share in the pre-deregulation period between June 2006 and February 2007. JJA's small market share may force its own-price elasticities to be huge.

[21]See appendix for Table 18.

KAL reached a 79.6% market share in the regulated period, which was four times higher than that of its main rival, AAR. The large number of passenger loads was accommodated with a 77.6% average load factor with frequent flights. Regarding capacity, KAL scheduled 13 more daily flights than AAR. The average Lerner indices for KAL predicted by a (i) SBNE in the regulated period was not available. On the other hand, AAR took a 19% market share, scheduling 8 daily flights. With a relatively low load factor of 54.2%, the average Lerner index for AAR was 30.7%.

One independent LCC, JJA, was flying the Seoul-Busan route before May 2008, but it stopped the route service in February 2007, operating turbo-prop aircraft with 78 available seats per airplane. JJA offered tickets at 80% of those of the two legacy carriers. Despite the low air fare, this independent LCC only recorded a 1.1% market share, scheduling two daily flights and recording a very low load factor of 24.1%. In this context, the Seoul-Busan route was dominated by the two legacy carriers in the pre-deregulation period. The average Lerner indices for the independent LCC predicted by a (i) SBNE was 31.5%. The implied marginal costs were in a reasonable order of magnitude for all flights except KAL flights.

The May 2008 Deregulation Act removed restrictions imposed on aircraft size for the non-scheduled airlines; thus, all independent LCCs were also able to operate jet aircraft with more than 100 seats each. However, no start-up independent LCCs began flight services between Seoul and Busan. On the contrary, ABL began flight service between Busan and Seoul since the launch of its business in October 2008. The joint ownership strategy between AAR and ABL had created a competitive response to another dependent LCC, JNA. AAR rebadged to ABL and had a code-share system with ABL. Extending its reputation through a code-share operation created customer loyalty to ABL, sharing the online reservation system for airline tickets. In addition, ABL charged air fare at 85.4% of KAL, which may have been able to draw fliers off from KAL. ABL scheduled a total of 12 daily flights, with a 50% increase in flight frequency over the pre-deregulation period, thus reaching a 33.3% market share (the market share in the regulated period was 19.1%). The AAR's rebadging strategy, i.e., replacing its prior service with ABL, does not constitute a new entry. Therefore the analysis of multiproduct firm activities does not apply to AAR. The average Lerner indices predicted by both a (i) SBNE and a (ii) MBNE had the identical value of 44.7%, which was 14% greater than that of the pre-deregulation period.

On the other hand, KAL operated under both badges, KAL and JNA, for only three months between January and March 2009. JNA offered tickets at 89.3% of the air fare provided by ABL, having a low market share of 2.9% with a load factor of 15.4%. The total number of daily scheduled flights decreased from 21.2 in the pre-deregulation period to 19.9 (including JNA flight frequency). For KAL flights alone, the average Lerner index predicted by a (ii) MBNE was 69.5%.

In summary, for both periods, the Seoul-Busan route has been dominated by the two legacy carriers and/or their subsidiary LCCs. The drop in passenger volume for KAL was mostly captured by ABL, a subsidiary LCC of AAR. Compared to the Jeju island routes, the inland routes were characterized as duopoly airline routes even in the post-deregulation period. Thus, both legacy carriers reaped higher yields through higher markups in the Seoul-Busan route than in the Jeju-Busan/Seoul routes.

4.1.3 Summary

The main purpose of supply side consideration along with the demand model in the previous chapter is an attempt to assess the benefit to air passengers and independent LCCs from the May 2008 Deregulation Act. The point estimates from the demand specification are used to recover the implied price-cost margins, thus marginal costs for each carrier-time-route observation. Then, the corresponding average own- and cross- price elasticities and Lerner indices are computed under two distinct supply model equilibrium concepts.

Within the five Jeju island routes (r = 1, 2, 3, 4, 5), the strategies for the two legacy carriers that involve responding with subsidiary LCCs are limited to two routes, Jeju-Seoul (r = 1) and Jeju-Busan (r = 2), where Korean Air operated under two brands, KAL and JNA, and AAR replaced its prior operation with ABL. For the Jeju-Cheongju route (r = 3), where competition between the two legacy carriers and the independent LCCs has intensified since the May 2008 Deregulation, the capability of the LCC business model in the Korean air transport industry is testable. Thus, I limited the analysis to the three routes out of five Jeju island routes where the LCCs operated at least a half year: Jeju-Seoul, Jeju-Busan, and Jeju-Cheongju. Regarding the inland routes (r = 6, 7), the Seoul-Gwangju route has only been operated by the two legacy carriers, KAL and AAR. The strategies for the two legacy carriers that involve responding with subsidiary LCCs are limited to the Seoul-Busan (r = 6) route where Korean Air operated under two brands, KAL and JNA, and AAR replaced its prior operation with ABL. However, there appears to be a failure in one of the two maintained hypotheses, either the nested logit or the short run profit maximization assumptions, for the KAL flights, at least, in the pre-deregulation period. Therefore, the results and implications in this chapter are limited to the three Jeju island routes out of seven routes.

The supply side considerations under static oligopoly competition models, i.e., SBNE and MBNE, provide the following implications for two routes out of seven routes across the Jeju island routes and the inland routes: Jeju-Seoul route (r = 1) and Jeju-Busan route (r = 2). The optimal pricing equations are reduced to price-cost margins involving equilibrium prices and demand parameters, thus depending on the structure imposed on the nested logit structure. The results on Lerner indices seem consistent with the patterns of average price elasticities predicted by nested logit models. As expected, the highest Lerner indices correspond to KAL flights having least elastic demand. According to the context, the Lerner indices - predicted by two different concepts - the SBNE and the MBNE - are compared. The MBNE is designed to predict a larger number of Lerner indices than the SBNE due to additional multiproduct firm-specific markup terms and potential diversion to the alternative produced by the same firm. During the post-deregulation period, the largest carrier, KAL, lost some sales to emerging LCCs, partly capturing the sales loss through its JNA operation. KAL's responding strategy with its own subsidiary LCC seems to be effective only in the Jeju-Seoul route. For the Jeju-Busan route, the MBNE indicates that substantial numbers of passengers would divert to ABL rather than JNA, where AAR rebadged to ABL and charged lower prices than KAL. As opposed to KAL, AAR recorded a larger market share and a higher Lerner index through its repositioning brand strategy to ABL in the Jeju/Seoul-Busan routes after deregulation.

On the contrary, the average Lerner indices increased for independent LCCs in the Jeju-Cheongju route in which two types of carriers – legacy carriers and independent LCCs - competed with each other for both time periods: Pre- and post- deregulation. For example, neither KAL nor AAR responded with its subsidiary LCC in the Jeju-Cheongju route. Independent LCCs, which operated small propeller aircraft with less than 80 seats per airplane in the regulated period, were restructured by expanding their capacities, i.e., increasing their fleet size up to more than 100 seats per airplane. Deregulation helped independent LCCs reach a 26% market share in the Jeju-Cheongju route, which exceeded their pre-deregulation market share by 12%.

In short, for both periods, the two legacy carriers still were characterized as dominant firms through joint ownership with their subsidiary LCC operations, i.e., either replacing their prior services with its an LCC badge or operating under both badges. I find weak evidence of benefits to independent LCCs from the May 2008 Deregulation Act. Post-act changes in the air craft sizes (measured in the number of available seats per airplane) are responsible for most of the increased market share for independent LCCs. Deregulation has not resulted in drastic changes in market share and Lerner indices for the independent LCCs although it has promoted new LCCs to enter the market and engage in competition.

Chapter 5

The Supply Side: Airline Flight Scheduling

Airlines compete via various qualities, e.g., departure times as well as prices. Since each route is part of a network and the plane used on one route is in use in prior and subsequent routes, carriers strategically schedule departure flights, maximizing overall route profitability.

5.1 Inter-Firm Departure Times Differentiation: *BtwnDIFF* Index

A spatial competition framework may be used to analyze airline routes where the air traveler's preferred departure times are non-uniformly distributed, and airline departure flights are differentiated over a time scale (i.e., a day). Theoretical models of spatial product differentiation indicate that firms face two opposing incentives: (1) minimize differentiation in order to steal customers from competitors, and (2) maximize differentiation in order to reduce price competition (Borenstein and Netz 1999). The former is consistent with the case where each carrier schedules its flights more closely to its rivals' flights, while the latter is consistent with the case where each carrier schedules its flights farther away from its rivals' flights.

In order to capture how an airline carrier chooses departure flight times, competing with not only its rivals' flights, but also its own flights, the measure used here, *BtwnDIFF*,[1] is adapted from a measure used by Borenstein and Netz [1999]. *BtwnDIFF* is the ratio of the inter-firm differentiation to the overall differentiation on a route. The value for *BtwnDIFF* can be larger than 1, implying the inter-firm differentiation is greater than the overall differentiation between all flights on a route, thus, greater than the intra-firm differentiation.[2] Departure times of all non-stop flights on a route are used to calculate *BtwnDIFF*.[3]

---

[1]There are n daily direct flights on a route, which depart at $d_1, \ldots, d_n$ minutes. Each departing time, $d_1, \ldots, d_n$, is expressed as minutes after 24AM (midnight). For example, if one flight is scheduled at 8AM and another is scheduled at 9AM, $|d_1 - d_2| = |480 - 540| = 60$ is the time distance between the first and second flight during a day, 24-hour clock.

The average distance between flights are measured as:

$$AVGDIFF = \frac{2}{n(n-1)} \sum_{i=1}^{n} \sum_{j>1}^{n-1} \left[min \left\{ \left| d_i - d_j \right|, 1440 - \left| d_i - d_j \right| \right\} \right]^{\alpha}, \ 0 < \alpha < 1 \tag{5.1}$$

where 1440 denotes the number of minutes in a day. *AVGDIFF* is minimized at zero when all flights depart at the same time. *AVGDIFF* is maximized when flights on a route are evenly distributed over a day, 24-hour clock. The power of α denotes the marginal effect of changes in time differences between flights on a route. I arbitrarily choose $\alpha = 0.5$, and the results do not qualitatively change across alternative values of α.

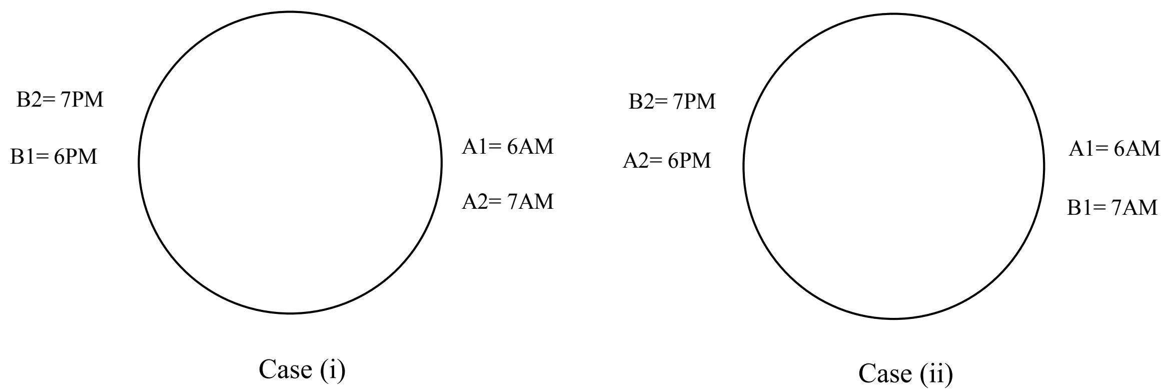
BtwnDIFF is the ratio of the average time distance between all flights scheduled by different carriers (applying $eq(1)$ to the subset of flight differences, $\left| d_i - d_j \right|$, where the carriers scheduling flights departing at d_i and d_j are different) to the average time distance among all flights (i.e., *AVGDIFF*). The between-firm differentiation index is abbreviated as *BtwnDIFF*.

[2]A ratio less than one for *BtwnDIFF* implies a ratio greater than one for the intra-firm differentiation, since the overall differentiation between all flights, *AVGDIFF*, is the same for all possible allocations of the given departure times across carriers. See footnote 24 Borenstein and Netz (1999). On monopoly routes, *BtwnDIFF* is not defined.

[3]From 10PM to 4AM, I don't observe any flights so I drop these 6 hours from 24 clocks cycle. The values for *BtwnDIFF* do not qualitatively change.

It is of interest to investigate the two opposing incentives in the airline flight scheduling competition (Figure 5.1) and how $BtwnDIFF$ would illustrate the configuration of the market structure: the number of carriers - flight frequency combination (Figure 5.1, 5.2 and 5.3).

Figure 5.1: Two opposing incentives in 2-2 market structure



As seen in Figure 5.1, in Case (i) carrier A schedules two flights in the morning ($dA1 = 6AM$, $dA2 = 7AM$), and carrier B schedules two flights in the evening ($dB1 = 6PM$, $dB2 = 7PM$), while in Case (ii) each carrier A and B schedules one morning ($dA1 = 6AM$, $dB1 = 7AM$) and one evening flight ($dA2 = 6PM$, $dB2 = 7PM$). For both cases, the average time distances among all four flights are the same, but each carrier schedules its own flight times far from its competitor's flights, making a cluster by carrier in Case (i) (clustered flights in the morning for carrier A and clustered flights in the evening for carrier B). As a consequence, $BtwnDIFF$ has a larger value in Case (i), 1.3072, than in Case (ii), 0.8321.[4] The value larger

[4]For case (i), $AVGDIFF_{case(i)}$ is the average time distance between each pairs of four flights, $|d_{A1} - d_{A2}| = |6AM - 7AM|$, $|d_{A1} - d_{B1}| = |6AM - 6PM|$, $|d_{A1} - d_{B2}| = |6AM - 7PM|$, $|d_{A2} - d_{B1}| = |7AM - 6PM|$, $|d_{A2} - d_{B2}| = |7AM - 7PM|$, $|d_{B1} - d_{B2}| = |6PM - 7PM|$.

The average time distance between all flights scheduled by different carriers is calculated by $|d_{A1} - d_{B1}| = |6AM - 6PM|$, $|d_{A1} - d_{B2}| = |6AM - 7PM|$, $|d_{A2} - d_{B1}| = |7AM - 6PM|$, and $|d_{A2} - d_{B2}| = |7AM - 7PM|$.

When $\alpha = 0.5$, $BtwnDIFF_{case(i)} = \frac{\frac{1}{4}\times(720^{0.5}+780^{0.5}+660^{0.5}+720^{0.5})}{\frac{1}{6}\times(60^{0.5}+720^{0.5}+780^{0.5}+660^{0.5}+720^{0.5}+60^{0.5})} = \frac{26.261}{20.089} = 1.307$.

For case (ii), $AVGDIFF_{case(ii)}$ is the average time distance between each pairs of four flights, $|d_{A1} - d_{A2}| = |6AM - 6PM|$, $|d_{A1} - d_{B1}| = |6AM - 7AM|$, $|d_{A1} - d_{B2}| = |6AM - 7PM|$, $|d_{A2} - d_{B1}| = |6PM - 7AM|$, $|d_{A2} - d_{B2}| = |6PM - 7PM|$, $|d_{B1} - d_{B2}| = |7AM - 7PM|$.

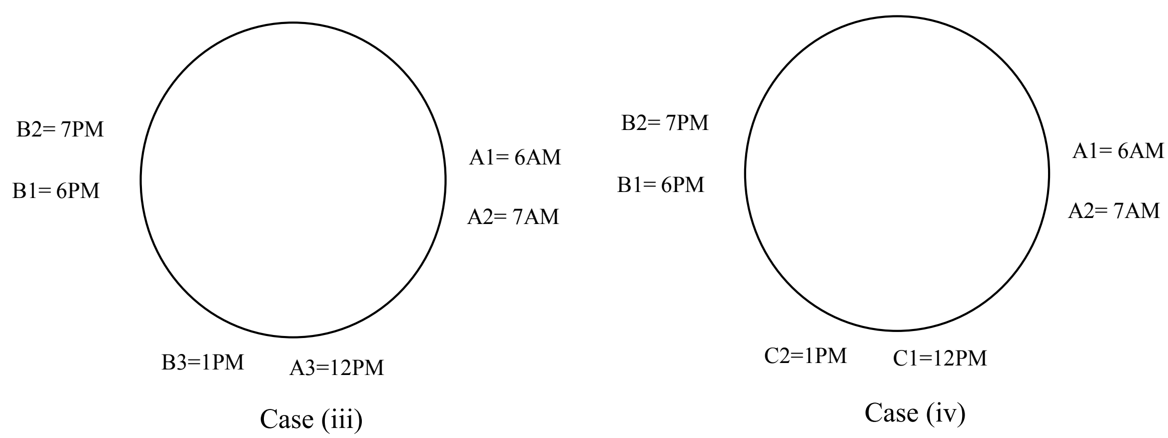
The average time distance between all flights scheduled by different carriers is calculated by $|d_{A1} - d_{B1}| = |6AM - 7AM|$, $|d_{A1} - d_{B2}| = |6AM - 7PM|$, $|d_{A2} - d_{B1}| = 6PM - 7AM$, and $|d_{A2} - d_{B2}| = |6PM - 7PM|$.

When $\alpha = 0.5$, $BtwnDIFF_{case(ii)} = \frac{\frac{1}{4}\times(60^{0.5}+780^{0.5}+660^{0.5}+60^{0.5})}{\frac{1}{6}\times(60^{0.5}+720^{0.5}+780^{0.5}+660^{0.5}+720^{0.5}+60^{0.5})} = \frac{16.718}{20.089} = 0.832$.

than 1 implies that carriers schedule departure flight times far from their rivals' flights rather than closely, and the value less than 1 indicates the opposite.

Figures 5.2 and 5.3 show how $BtwnDIFF$ may illustrate different market structures. First, $BtwnDIFF$ would predict higher values as the number of carriers increases on the route, while holding the flight frequency and the flight schedule configuration fixed in Figure 5.2. Second, compared to Figure 5.1, Figure 5.3 presents carriers A and B scheduling one additional flight, respectively. The more inter-firm differentiation there is, the larger the $BtwnDIFF$.

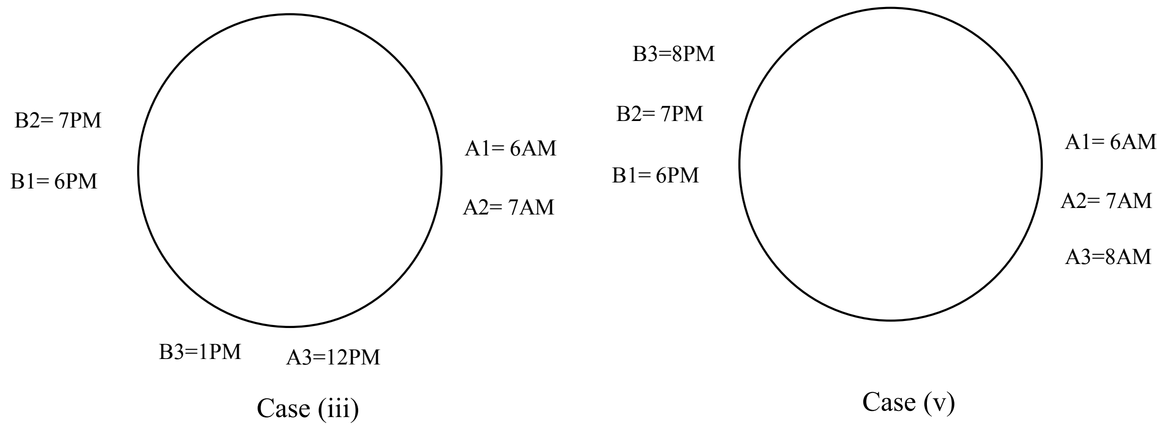
Figure 5.2: 3-3 market structure vs 2-2-2 market structure



Case (iii) in Figure 5.2 shows that two carriers A and B schedule three flights, $dA1 = 6AM$, $dA2 = 7AM$, and $dA3 = 12PM$ for carrier A, and $dB1 = 6PM$, $dB2 = 7PM$, and $dB3 = 1PM$ for carrier B. For Case (iv), let's suppose that a third carrier C starts the route service, scheduling two flights, $dC1 = 12PM$ and $dC2 = 1PM$, around lunchtime far from its rivals' flights. $BtwnDIFF$ is greater than one in both cases, but has a slightly larger value in Case (iv), where $BtwnDIFF_{case(iv)}$=1.1461, than in Case (iii), where $BtwnDIFF_{case(iii)}$=1.1420.[5]

[5]See appendix section.Calculation for the inter-firm departure flight times differentiation index, $BtwnDIFF$ for calculation.

Figure 5.3: 3-3 market structure and *BtwnDIFF*



Given the same market structure, i.e., where both the total number of flight frequency and carriers are fixed, *BtwnDIFF* maps the carrier's strategic behaviors. The impact of changing from a 2-2 market structure in Case (i) in Figure 5.1 to 3-3 market structure (either Case (iii) or (v)) in Figure 5.3 reflects the degree of inter-firm differentiation. A movement from a 2-2 market structure in Case (i) in Figure 5.1 to 3-3 market structure in Case (iii) in Figure 5.3 decreases the index to 1.1420 while a movement from a 2-2 market structure in Case (i) in Figure 5.1 to 3-3 market structure in Case (v) in Figure 5.3 increases the index to 1.3575. For both Cases (iii) and (v), the two carriers locate their third flight farther from each other rather than more closely to each other, but the departure time schedules in Case (v) crowd together a carrier's own flights. The Case (v) configuration simply leads to market segmentation by carriers: Clustered flights in the morning for carrier A and clustered flights in the evening for carrier B. However, the departure flight schedules contain three cluster groups in Case (iii): Clustered flights in the morning for carrier A, clustered flights at lunchtime, and clustered flights in the evening for carrier B. *BtwnDIFF* is greater than 1 in both cases. *BtwnDIFF* has a value of 1.3575 in Case (v), which exceeds 1.1420 in Case (iii).[6]

[6] See appendix section.Calculation for the inter-firm departure flight times differentiation index, *BtwnDIFF* for calculation.

5.2 Predictions

A few independent low cost carriers had flown Jeju island routes before May 2008, but most of these were non-scheduled air service carriers subject to regulated market policy. These restrictions on non-scheduled air service carriers, combined with irregular flights service, greatly limited their aircraft availability and selection. The May 2008 Deregulation Act removed restrictions imposed on aircraft size for the non-scheduled airlines; thus, all independent LCCs were then able to operate jet aircraft with more than 100 seats each.

Several LCCs (including both dependent and independent LCCs) have been established over the last three years, although two of the independent LCCs have since ceased operations. The remaining independent LCCs were restructured by expanding their capacities. For example, Jeju Air (JJA) permanently removed all four Dash 8 Q400s, turboprop aircraft with 78 available seats per airplane, in June 2010, and took delivery of one Boeing 737 in 2011 on top of its existing fleet of five B737s. Another independent LCC, Eastar Jet (ESR) expanded its fleet up to six Boeing 737s in March 2010. In addition, they increased their daily flight frequency on some routes (Jeju-Cheongju/Seoul).

In response to the creation of the independent LCCs the two established full service carriers could establish subsidiary LCCs of their own, either replacing their prior services with them or competed with them. For example, AAR replaces its service on some routes with its own LCC, ABL, and KAL's LCC subsidiary LCC, JNA, competed with KAL flights on some routes. As a result, major airlines could schedule their departure flight times strategically either farther from or closer to independent LCC flights in response to the intensified competition from LCCs. Moreover, LCCs competed by means of non-price (e.g., quality) product differentiation strategies. It is therefore of interest to investigate whether the pattern for scheduling departure flight times has changed since the 2008 Deregulation Act.

- *Hypothesis* In the post-deregulation period, carriers strategically schedule their departure flight times either farther from or closer to their rivals' flight times.

As shown in Tables 4.1, 4.5, 4.9, and 4.11 in chapter 4, the average prices for major airlines slightly increased in real terms. Average prices for independent LCCs only slightly changed (decreased in the Jeju-Cheongju route, but increased in the other two Jeju island routes) in real terms after deregulation. With small variations in prices within carriers, carriers would have engaged in non-price dimension competition. Thus, which incentive - two opposing incentives: (1) minimized/(2) maximized departure times differentiation across carriers on a route - would dominate in the post-deregulation period is testable. When prices are set exogenously, then it follows that carriers would minimize departure time differentiation in the absence of price competition. On the other hand, carriers might increase departure time differentiation in order to soften price competition in the presence of potential intensive price competition. Since the prices are not set exogenously in the Korean airline industry, and consumers are not uniformly distributed, the Hotelling's conjecture (i.e., carriers minimize departure time differentiation in order to steal passengers from each other) cannot be directly applied to the data.

- Deregulation period: $Deregulation$

I posit that carriers strategically schedule their flight times either farther from or closer to their rivals' flight times on the routes where new entry of independent LCCs are present in the post-deregulation period. $Deregulation$ is equal to one for the post-deregulation period and is equal to 0 for the period prior to deregulation.

- Degree of competition: HHI

To test the hypothesis, the Herfindahl Index, HHI, is defined as a measure of the degree of competition among carriers on a route, ranging from zero to one. This index is calculated as the sum of squares of the flight frequency shares of all airlines. A higher HHI number indicates that the route is less competitive, while a lower HHI number indicates the opposite. The values of HHI reflect the number of carriers as well as inequality in market shares across carriers on a route. It decreases as the number of carriers increases, given a constant flight frequency number. The value of HHI would be greater if the inequalities in market shares between carriers are larger while holding a fixed number of carriers.

- Load factor: $Loadfactor$

The load factor on a route, which is the percentage of seats occupied, would affect the degree of between-firm differentiation. The $Loadfactor$ variable is supposed to have opposing effects on the inter-firm differentiation with respect to the departure times. From the supply side perspective, the incentive (or ability) for carriers to compete on departure time would be reduced on the routes with high load factors when flights are almost full capacity. Consequently, there might be no reason for each carrier to schedule its flights closer to its rivals' flights in order to steal air passengers from rivals. In this context, *Loadfactor* is expected to have positive effects on the inter-firm departure flight times differentiation, leading to more product differentiation between carriers when the average load factors are high. With regards to the demand-driven incentive, *Loadfactor* might have negative effects on the inter-firm departure flight times differentiation. Load factors are high during peak-demand season/hours, meaning that demand is high relative to the number of seats offered. Carriers would schedule their flight times closer to their rivals' flights in order to capture the high demand on peak-hours during a day, stealing air passengers from competitors.

- Lerner index: *Lerner*

The route-specific profitability would drive carriers to schedule flight times either more closely to or farther from their rivals' flights. The *Lerner* index, or price-cost margin, can be used as a measure of the firms' market power. This index ranges from a high of one to a low of zero, with higher numbers implying greater market power.[7] The *Lerner* variable is hypothesized to have opposing effects on the inter-firm differentiation with respect to the

[7]The assumption that the price charged on flight service is never less than the carrier paid to create it, cost, holds under the static profit maximizing model.

departure times. On a route with higher Lerner indices as exogenous, a carrier would have a greater incentive to schedule flight times closer to each other's flights, drawing passengers off from the most nearby flights from rivals. In other words, there is less incentive for carriers to schedule their flights closer to their rivals' flights in order to steal customers when the average price-cost margins on the route are low.

On the other hand, carriers might try to differentiate their departure flight times farther from each other when the route-specific average profitability per passenger is high, avoiding potentially intense price competition. Since Lerner variables used in data are recovered after the demand parameters are first obtained and then inserted in the pricing equation (7) (equations (8) and (9)) for under the single product firm assumption (for under the multiproduct firm assumption), the implied markups clearly depend on the assumed functional form for the demand specification. That is, the size of markups is inversely proportional to own price elasticities. Thus, at a time when the average route-specific Lerner indices are high, carriers would have more to lose by concentrating on price competition, i.e., price cuts in order to gain additional passenger load if they seek to increase revenues since demand for flight services are less elastic at those times.

With regards to the relationship between market structure and $BtwnDIFF$, both the number of carriers and daily flight frequency on a route are included in the regression analysis.

- The number of carriers on a route: *Carrier*

The measure for the inter-firm departure flight time differentiation, $BtwnDIFF$, increases with the number of carriers, holding a constant number of total flight frequencies and the flight schedule configuration fixed on a route. As shown in Case (iii) and (iv) in Figure 5.2, $BtwnDIFF$ has a larger value when three carriers, A,B, and C, operated on a route than two carriers, A and B, did, while holding the flight schedule configuration fixed. Thus, the number of carriers on a route is expected to have a positive effect on $BtwnDIFF$.

- The number of total daily flights on a route: $Flight$

The total flight frequency on a route controls for the market size. Holding a fixed number of carriers, the number of total flight frequency scheduled by each carrier illustrates the degree of inter-firm differentiation. Compared to Case (i) in Figure 5.1, each carriers A and B schedules a third additional flight at lunchtime in Case (iii) in Figure 5.3, and even farther from the rivals' flights in Case (v) in Figure 5.3. Case (v) has a larger value of $BtwnDIFF$ than Case (i), and Case (iii) has a lower value of $BtwnDIFF$ than in Case (i). That is, carriers try to differentiate their departure flight times farther from each other more in Case (v) than in Case (iii). Therefore, moving from 2-2 market structure (in Figure 5.1) to 3-3 market structure (in Figure 5.3) $BtwnDIFF$ would demonstrate the degree of inter-firm differentiation as each carrier expands flight frequency, e.g., $Flight$ variable might have a positive effect on $BtwnDIFF$ in Case (v), but have a negative effect on $BtwnDIFF$ in Case (iii).

5.3 Model

To provide empirical test results, I present two different model specifications that differ in their sets of explanatory variables.[8] Model 1 controls for a route-specific capacity constraint, $Loadfactor$. Instead, Model 2 controls for route-specific profitability per passenger, $Lerner$. I assume a log-log relationship.

[8]The present Models 1 and 2 consider the impact of each independent variable in an additive way, assuming that the marginal effect of competition, HHI, on inter-firm flight times differentiation, $BtwnDIFF$, is the same for any time period.

Given that the estimated effect of competition might depend on deregulation, we can account for this intuition with an interaction term, $LnHHI_t * Deregulation_t$. In the estimation results for each of the routes, however, the point estimates for the $LnHHI_t * Deregulation_t$ variable are insignificant at 5% level, implying that there would be no significant difference in the marginal effect of competition on $BtwnDIFF$ across the two time periods, pre- and post- deregulation.

- Model 1

The following equation (10) addresses Model 1. I observe $t = 1, \ldots, T$ time period (June 2006 to October 2010) on routes $r = 1,2,3,4,5,6,7$. All explanatory variables are assumed to have route-specific effects. The error term ε is assumed to be $i.i.d$

$$LnBtwnDIFF_t = \beta_0^r + \beta_1^r LnHHI_t + \beta_2^r Deregulation_t + \beta_3^r LnLoadfactor_t + \beta_4^r LnFlight_t + \beta_5^r LnCarrier_t + \varepsilon_t \quad (10)$$

where $LnBtwnDIFF_t$ is the logarithm of the between-firm differentiation index, $BtwnDIFF_t$; $LnHHI_t$ is logarithm of the Herfindahl index based on flight frequency shares among all carriers; $Deregulation_t$ is a dummy variable, indicating the observations following the May 2008 deregulation; $LnLoadfactor_t$ is logarithm of the load factors; $LnFlight_t$ is logarithm of the total flight frequency; $LnCarrier_t$ is logarithm of the number of carriers.

- Model 2

Equation (11) addresses Model 2. I observe $t = 1, \ldots, T$ time periods (June 2006 to October 2010) on routes $r = 1,2,3,4,5,6,7$. All explanatory variables are assumed to have route-specific effects. The error term ε is assumed to be $i.i.d.$

$$LnBtwnDIFF_t = \beta_0^r + \beta_1^r LnHHI_t + \beta_2^r Deregulation_t + \beta_3^r LnLerner_t + \beta_4^r LnFlight_t + \beta_5^r LnCarrier_t + \varepsilon_t \quad (11)$$

where $LnBtwnDIFF_t$ is the logarithm of the between-firm differentiation index, $BtwnDIFF_t$; $LnHHI_t$ is logarithm of the Herfindahl index based on flight frequency shares among all carriers; $Deregulation_t$ is a dummy variable, indicating the observations following the May 2008 deregulation; $LnLerner_t$ is logarithm of the Lerner indices; $LnFlight_t$ is logarithm of the total flight frequency; $LnCarrier_t$ is logarithm of the number of carriers.

5.4 Data and Estimation Results: Route-by-Route Estimates

Here I provide route-by-route estimation results. The two explanatory variables, $Flight$ and $Loadfactor$, are weighted by each carrier's flight frequency shares on a route and Lerner is weighted by each carrier's passenger load shares on a route. From July 2006 to October 2010, a total of 52 months were observed.

To provide an econometric analysis, two demand specifications that only differ in one explanatory variable are compared: $Loadfactor$ in Model (1) controls for the route-specific capacity constraints that may affect the departure times scheduling strategy, and *Lerner* in Model (2) controls for the route-specific profitability per passenger that may affect the departure times scheduling strategy. Each column in all tables for each route below will show estimation results from Model (1) and Model (2), respectively.

One potential problem can arise here due to endogeneity. The two variables, $Loadfactor$ and *Lerner*, would be correlated to the error term if the error term incorporates unobserved seasonal effects or cyclical fluctuations. $Loadfactor$ in Model (1) may be endogenous with respect to the error term, but the specification test does not reject the null hypothesis that $Loadfactor$ is exogenous. The same specification test is conducted for *Lerner* in Model (2), and again, it does not reject the null hypothesis that *Lerner* is exogenous. Thus, $Loadfactor$ and *Lerner* are assumed to be exogenous in each model specification.

5.4.1 Jeju Island Routes

Within the Jeju island routes, the demands for five direct routes ($r = 1,2,3,4,5$) were estimated in an earlier chapter. In this chapter the analysis is limited to only three routes because only three routes had significant competition (e.g., over half a year) from independent LCCs: Jeju-Seoul ($r = 1$), Jeju-Busan ($r = 2$), and Jeju-Cheongju ($r = 4$).

5.4.1.1 Jeju-Seoul Route (r =1)

Jeju-Seoul is the largest domestic sector for LCCs. KAL, the country's largest legacy carrier, launched its own subsidiary LCC, JNA, and started the route service in July 2008, two months after the May 2008 Deregulation Act. On the Jeju-Seoul route, several LCCs have been established over the last three years: two independent LCCs, ESR and JJA, as well as the dependent LCC, JNA. On the other hand, two other independent LCCs ceased operations in 2008 – HAN in November and ONA in December - due to intense competition, worsening economic conditions, increasing fuel costs, and difficulties in securing additional funding. The emergence and failure of LCCs are linked to changes in market structure, thus competition level, among carriers. Consequently carriers are likely to diversify their competition strategies, i.e., responding with strategic departure flight times scheduling.

Table 5.1 presents summary statistics for the main explanatory variables, average monthly values of the between-firm differentiation indices and the Herfindahl indices from two perspectives: Pre- and post-deregulation.[9] The values of indices in each observation are derived from all direct flights on a directional route, from Seoul to Jeju.[10]

Table 5.1: Descriptive statistics: Jeju-Seoul route (r = 1)

1.Jeju-Seoul route	Pre-deregulation				Post-deregulation			
Variable	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max
$BtwnDIFF$	0.9943	0.0058	0.9876	1.0013	0.9939	0.0018	0.9922	0.9977
HHI	0.3326	0.0426	0.2880	0.4340	0.2351	0.0269	0.1890	0.2940
Number of carriers	3.8	0.4	3.0	4.0	5.1	0.5	4.0	6.0
Flight frequency	61.4	8.7	47.6	81.8	77.8	8.0	57.8	92.1
Lerner indices	0.4001	0.0283	0.3457	0.4710	0.2979	0.0242	0.2661	0.3897
Load factor	0.8113	0.0751	0.6702	0.9598	0.7750	0.0803	0.6441	0.9557

It is not clear to see whether the carriers' departure flight times scheduling patterns have significantly changed since the deregulation in May 2008. No significant changes

[9] Time subscripts are omitted. The numbers are rounded.

[10] I also compared the value with Jeju to Seoul observation, but the results are qualitatively insensitive. The same result applies to the rest of routes.

in $BtwnDIFF$ were reported, displaying moderate variation over time. $BtwnDIFF$ had a 1.0013 maximum value during the regulated period, implying that the average inter-firm differentiation was more than the average overall differentiation between all flights on the route, thus, more than the average intra-firm differentiation. $BtwnDIFF$ decreased in the deregulated period, having the index values less than 1 with smaller standard deviation.

Unlike $BtwnDIFF$, the average values for all explanatory variables substantially changed in the post-deregulation period. The degree of competition, measured by the Herfindahl indices, rose, indicating that the Jeju-Seoul route service had become more competitive. In addition, the number of carriers, as well as the route-wide total flight frequencies increased. A slight decrease in $BtwnDIFF$ mentioned earlier, combined with a decrease in HHI, may provide weak evidence that carriers would tend to schedule their flight times closely to nearby flights located by the rivals as competition between firms intensifies over time.

Regarding the variables that also depend on the demand-driven concerns, data showed a drop in both $Lerner$ and $Loadfactor$. Average values for $Lerner$ substantially decreased, possibly due to the fact that several new independent LCCs started to fly the Jeju - Seoul route, but two of them ceased operations, causing the average price-cost markups to drop. In a similar way, average values for $Loadfactor$ slightly declined, showing a larger standard deviation than the pre-deregulation period.

Table 5.2: OLS estimation of log-log specification: Jeju-Seoul route (r = 1)

1. Jeju-Seoul route	Dependent variable Ln*BtwnDIFF*	
Explanatory variable	Model (1)	Model (2)
LnHHI	-0.00007	-0.00125
	(0.004)	(0.006)
Deregulation	-0.0071***	-0.0073*
	(0.002)	(0.003)
LnLoadfactor	-0.0249***	
	(0.004)	
LnLerner		-0.0043
		(0.010)
LnFlight	0.0197***	0.0135*
	(0.005)	(0.006)
Number of carriers	0.0007	0.0015
	(0.001)	(0.001)
Constant	-0.1744***	-0.1263**
	(0.035)	(0.040)
N	52	52
adj. R-sq	0.591	0.239

Robust standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

As shown in the Table 5.2, the primary conclusions from summary statistics mostly hold up in the OLS regression results. The negative coefficient estimates for $LnHHI$ in both specifications are not of expected sign.[11] I expected to find a positive relationship between $LnBtwnDIFF$ and $LnHHI$, showing the associated movements in the same direction. Its virtually zero coefficients are not close to the 5% significance level. The impacts of $Deregulation$ on the degree of inter-firm departure time differentiation are all negative and robust across models. The smaller gaps among carriers' flight times were found in the deregulated period.

The coefficient estimate for $LnLoadfactor$ is negative in Model (1) and statistically significant. This is not surprising because the Jeju-Seoul route is characterized as the highest load factor route with a 95.98% maximum value of average load factors. The negative sign

[11]In order to see whether carriers strategically schedule their departure flight times either farther from or closer to their rivals' flight times, the null hypothesis that H_0 : The coefficient for $LnHHI$ is equal to zero (against the alternative hypothesis H_1 : The coefficient for $LnHHI$ is not equal to zero) was tested for Models 1 and 2, respectively. According to the two-tailed t statistics for this hypothesis, there is no statistical evidence to reject the null hypothesis.

indicates that high load factors would lead to a minimum departure flight times differentiation between competitors. In other words, the result on *LnLoadfactor* accounts for departure times crowding into peak-demand hours/months, which would be associated with less departure times differentiation.

The route-specific flight service profitability, *Lerner*, in Model (2) has a negative effect on *BtwnDIFF*, but is insignificant, implying that the higher the profitability per passenger, the smaller the *BtwnDIFF*. The minimum differentiation incentive may drive the carriers to schedule their flights more closely to their rivals' flights, drawing off passengers from nearby flights. With regards to the impact of market structure on the degree of inter-firm departure time differentiation, both the departure flight frequency and the number of carriers are controlled. The coefficient estimates for both *LnFlight* and *LnCarrier* are all positive; however, the results on *LnCarrier* are not significant. The more frequent flights, given a fixed number of carriers on the Jeju-Seoul route, would provide larger values of *BtwnDIFF*. Similar to interpreting the estimation results for *LnFlight*, more varieties of carriers, given a constant number of flight frequency on the Jeju-Seoul route, would generate larger values of *BtwnDIFF*. This finding is consistent with the example (recall Cases (iii) and (iv) in Figure 5.2).

5.4.1.2 Jeju-Busan Route (r =2)

Jeju-Busan is the second largest domestic route for LCCs. The two major airlines actively engaged in competition, responding with their own subsidiary LCCs. In November-December 2008, AAR established ABL, and replaced its prior services with it. AAR minimized switching costs for their passengers through the code-share operation system with ABL, charging air fare higher than the competing independent LCCs, but lower than KAL. Moreover AAR/ABL scheduled a total of 8.8 daily flights, which exceeded its pre-deregulation flight frequency by 87.2%. AAR reached a 32.5% market share through its ABL operation, which exceeded the market share of 23.7% in a regulated period. In contrast to AAR's repositioning brand strategy KAL flew under the JNA badge in the Jeju-Busan route between April and November 2009, maintaining its KAL badge as well.

Table 5.3 reports the available variables.[12] The data consist of route-specific average monthly inter-firm departure flight times differentiation indices, the Herfindahl indices, and other explanatory variables from two perspectives: pre- and post-deregulation. The values of indices in each observation are derived from all nonstop flights on a directional route, from Busan to Jeju.

Table 5.3: Descriptive statistics: Jeju-Busan route (r = 2)

2. Jeju-Busan route	Pre-deregulation				Post-deregulation			
Variable	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max
$BtwnDIFF$	0.9825	0.0048	0.9713	0.9888	0.9809	0.0068	0.9694	0.9934
HHI	0.4369	0.0474	0.4010	0.5620	0.3467	0.0492	0.2630	0.4040
Number of carriers	2.9	0.3	2.0	3.0	3.5	0.5	3.0	4.0
Flight frequency	17.7	1.5	15.0	20.0	20.9	3.0	14.5	25.8
Lerner indices	0.6047	0.0631	0.4895	0.7399	0.4055	0.0475	0.3459	0.6023
Load factor	0.7529	0.0886	0.6146	0.9275	0.7848	0.0874	0.6303	0.9448

In all 52 months observations, $BtwnDIFF$ is less than 1, implying that the average inter-firm differentiation is less than the average overall differentiation between all flights

[12] Time subscripts are omitted. The numbers are rounded.

on the route, therefore, less than the average intra-firm differentiation. The average values for *BtwnDIFF* are more dispersed in the post-deregulation period, having a slightly larger standard deviation.

The average values for all explanatory variables significantly differ between the two time-periods, pre- and post-deregulation. *HHI* decreased over time, indicating that competition intensified on the Jeju-Busan route. The number of carriers, as well as the route-wide total flight frequencies increased. A huge drop in the average values for *Lerner* is found in the post-deregulation. The change in the market structure would demonstrate this enormous drop in *Lerner*. Prior to the May 2008 Deregulation, the route was dominated by the two legacy carriers, KAL and AAR, recording their total passenger load shares of 91.7%. KAL reached a 67.8% market share, which was almost three times higher than the share of its main rival, AAR. Since May 2008, new LCCs started to fly the route, drawing passengers off from the major airlines. As a consequence, *Lerner*, calculated using passenger load shares among all carriers, dropped sharply in the post-deregulation period. *Loadfactor* increased, meaning a higher load factors for average carriers. One possible explanation for this is due to the emergence of effectively competitive entrants with high load factors in the Jeju-Busan route.

Table 5.4: OLS estimation of log-log specification: Jeju-Busan route (r = 2)

2. Jeju-Busan route	Dependent variable Ln*BtwnDIFF*	
Explanatory variable	Model (1)	Model (2)
LnHHI	0.009	0.007
	(0.009)	(0.011)
Deregulation	-0.007***	-0.006*
	(0.001)	(0.002)
LnLoadfactor	-0.015*	
	(0.006)	
LnLerner		0.007
		(0.007)
LnFlight	0.030***	0.027***
	(0.005)	(0.004)
Number of carriers	0.007*	0.008**
	(0.003)	(0.003)
Constant	-0.245***	-0.222***
	(0.034)	(0.027)
N	52	52
adj. R-sq	0.576	0.51

Robust standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Point estimates are similar across Models (1) and (2), supporting the primary conclusions from descriptive statistics. The coefficient estimates for LnHHI are all positive, but not close to the 5% significance level.[13] The positive effects suggest the associated movements between degree of competition and the resulting pattern on route-specific scheduling patterns moved in the same direction. This would imply that for each carrier the minimum differentiation incentive as opposed to the rival's flight times outweigh the maximum differentiation incentive when competition intensifies on the Jeju-Busan route. The estimated impacts of $Deregulation$ on the degree of inter-firm departure flight times differentiation are negative and robust across models. The size of the gaps between carriers' departure flight times may be less in the post-deregulation period.

[13] In order to see whether carriers strategically schedule their departure flight times either farther from or closer to their rivals' flight times, the null hypothesis that H_0 : The coefficient for $LnHHI$ is equal to zero (against the alternative hypothesis H_1 : The coefficient for $LnHHI$ is not equal to zero) was tested for Models 1 and 2, respectively. According to the two-tailed t statistics for this hypothesis, there is no statistical evidence to reject the null hypothesis.

The coefficients for other time varying factors are significant. First, the coefficient estimate for Ln$Loadfactor$ is negative in Model (1) and statistically significant. Similar to the Jeju-Seoul route, the Jeju-Busan route is characterized as a high load factor route with a 94.48% maximum value of average load factors. The negative sign indicates that high load factors would lead to minimum differentiation between competitors, taking into account departure time crowding into peak-demand times.

Unlike the Jeju-Seoul route, *Lerner* has a positive effect on $BtwnDIFF$ in Model (2), implying that the higher the profitability per passenger, the greater $BtwnDIFF$. The positive estimated coefficient for Model (2) can be interpreted as the carriers' desire to maximize differentiation from the rivals' flights, avoiding severe price competition.

Furthermore, the estimated impacts of both Ln$Flight$ and Ln*Carrier* are more robust. The coefficient estimates for these two variables are all positive and highly significant. The more frequent flights, given a fixed number of carriers on the Jeju-Busan route, would provide larger values of $BtwnDIFF$. Similar to interpreting the estimation result for Ln$Flight$, more varieties of carriers, given a constant number of flight frequency on the Jeju-Busan route, would produce larger values of $BtwnDIFF$.

5.4.1.3 Jeju-Cheongju Route (r = 3)

The carriers on the route have been characterized by two types: the two major airlines and independent LCCs. Neither KAL nor AAR launched their own subsidiary LCCs on the Jeju-Cheongju route. Only two entries of independent LCC are observed during full time period: JJA and ESR.

Table 5.5 describes the average values for the main variables.[14] The data consist of route-specific average monthly inter-firm departure flight times differentiation indices, the Herfindahl indices, and other explanatory variables, from two perspectives: pre- and post-deregulation. The values of indices in each observation are derived from all nonstop flights on a directional route, from Cheongju to Jeju.

Table 5.5: Descriptive statistics: Jeju-Cheongju route (r = 3)

3. Jeju-Cheongju route	Pre-deregulation				Post-deregulation			
Variable	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max
BtwnDIFF	0.9481	0.0075	0.9440	0.9690	0.9594	0.0104	0.9430	0.9800
HHI	0.3369	0.0021	0.3340	0.3410	0.2866	0.0332	0.2540	0.3440
Number of carriers	3.0	0.0	3.0	3.0	3.8	0.4	3.0	4.0
Flight frequency	10.9	0.6	9.5	12.0	11.9	1.3	9.9	14.7
Lerner indices	0.5614	0.0298	0.4887	0.6035	0.5472	0.0450	0.4342	0.6168
Load factor	0.7676	0.0914	0.5857	0.9145	0.7496	0.0901	0.5868	0.8958

Data strongly support the structural change since the Deregulation Act of May 2008. It is clear to see whether the departure flight scheduling patterns have significantly changed after May 2008. In all 52 months of observations, $BtwnDIFF$ is less than 1, with a strong tendency to increase in the deregulated period. The index values less than 1 indicate that the inter-firm differentiation is less than the overall differentiation between all flights on the route. The Herfindahl indices decreased, implying that the level of competition increased

[14] Time subscripts are omitted. The numbers are rounded.

on the Jeju-Cheongju route. The number of carriers increased, reflecting the entries of two independent LCCs, JJA in June 2008, and ESR in June 2009. The route-wide total flight frequencies increased as well. Average values for both $Lerner$ and $Loadfactor$ declined slightly.

Table 5.6: OLS estimation of log-log specification: Jeju-Cheongju route (r = 3)

3. Jeju-Cheongju route	Dependent variable Ln*BtwnDIFF*	
Explanatory variable	Model (1)	Model (2)
LnHHI	-0.1049***	-0.1171***
	(0.026)	(0.032)
Deregulation	-0.00089	-0.00074
	(0.002)	(0.002)
LnLoadfactor	-0.0034	
	(0.008)	
LnLerner		0.0154
		(0.014)
LnFlight	0.0516***	0.0537***
	(0.009)	(0.008)
Number of carriers	-0.0126	-0.0154
	(0.007)	(0.008)
Constant	-0.4740***	-0.4848***
	(0.055)	(0.052)
N	52	52
adj. R-sq	0.763	0.771

Robust standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

As shown in the Table 5.6, the coefficient estimates for LnHHI in Model (1) and (2) are negative and statistically significant.[15] Its negative impacts on Ln$BtwnDIFF$ indicate a tendency for competition towards greater inter-firm differentiation in departure flight times. The magnitude of the effect is considerably larger (in absolute values) than the other two Jeju island routes. The negative and highly significant coefficients are due to the industry competition configuration. Independent LCCs would distinguish their flights from the two

[15] In order to see whether carriers strategically schedule their departure flight times either farther from or closer to their rivals' flight times, the null hypothesis that H_0 : The coefficient for $LnHHI$ is equal to zero (against the alternative hypothesis H_1 : The coefficient for $LnHHI$ is not equal to zero) was tested for Models 1 and 2, respectively. Based on the two-tailed t statistics, one can reject the null hypothesis.

legacy carriers by means of product differentiation strategy. At the same time major airlines would tend to schedule their departure flight times more strategically (i.e., farther from their rivals' flight times in our context) in response to the intensified competition from LCCs. Thus, the incentive to adjust departure flight times to compete with their rivals attracts the carriers including both the two legacy carriers and independent LCCs, yielding a relatively large size of coefficient.

The negative coefficients for *Deregulation* are not of expected sign, and statistically insignificant.[16] This virtually zero coefficient could be biased downward given that the error term and deregulation dummy variable are negatively associated.

The point estimation results on Ln*Loadfactor* and Ln*Lerner* are statistically insignificant. The coefficient estimate for Ln*Loadfactor* is negative in Model (1). Similar to the other two Jeju routes, the Jeju-Cheongju route is also characterized as a high load factor route with a 91.5% maximum value of load factors. This negative sign indicates that high load factors lead to minimum differentiation between competitors, taking into account departure time crowding into peak-demand times. Similar to interpreting the estimation result in the Jeju-Busan route, Ln*Lerner* has a positive effect on *BtwnDIFF* in Model (2), implying that the higher the profitability per passenger, the greater the *BtwnDIFF*. In other words, carriers try to differentiate their departure flight times farther from each other when the route-specific average profitability per passenger is high, reducing potentially intense price competition.

With regards to the impact of market structure on the degree of inter-firm departure time differentiation, both the departure flight frequency and the number of carriers are included. The coefficient estimates for Ln*Flight* are all positive and robust in both specifications. The more frequent flights, given a fixed number of carriers on the Jeju-Cheongju route, would

[16]I tested the null hypothesis that H_0 : The coefficient for *Deregulation* is equal to zero (against the alternative hypothesis H_1 : The coefficient for *Deregulation* is either greater than or equal to zero) given that inter-firm differentiation increases with competition in the Jeju-Cheongju route. According to the one-tailed t-test statistics results, there is no statistical evidence to reject the null hypothesis.

predict a larger value of *BtwnDIFF*. The coefficient estimates for Ln*Carrier* are negative, but the estimated impacts are not significant.

5.4.2 An Inland Route

For the inland routes, air travel demands for two routes ($r = 6, 7$) were estimated in an earlier chapter, but the Seoul-Gwangju route has only been operated by the two legacy carriers, KAL and AAR. The analysis of whether carriers strategically schedule their departure flight times either far from or more closely to their rivals' flights in the post-deregulation period is limited to the Seoul-Busan route ($r = 6$).

5.4.2.1 Seoul-Busan Route (r = 6)

The Seoul-Busan route is the third largest domestic route for LCCs and the largest inland sector for LCCs. In October-November 2008, AAR rebadged to ABL. By contrast, KAL flew under both KAL and JNA badge, only for three months between January 2009 and March 2009.

Table 5.7 presents summary statistics for the average values of the inter-firm departure flight time differentiation indices, the Herfindahl indices, and the other explanatory variables,[17] from two perspectives: Pre- and post-deregulation.[18] The values of indices in each observation are derived from all nonstop flights on a directional route, from Busan to Seoul.

[17] See chapter 4 section 4.1.2. and chapter 6 section 6.3.1.

Since Lerner variables used in data are recovered after the demand parameters are first obtained and then inserted in the pricing equation (7) (equations (8) and (9)) for the single product firm assumption (for a multi-product firm assumption), the implied markups under the static profit maximization assumption clearly depend on the assumed functional form for the demand specification. That is, the size of markups is inversely proportional to own price elasticities. As seen in section 4.1.2.1 and section 6.3.1, the KAL flights' were estimated to be inelastic at least prior to deregulation.These estimated own-price elasticities led to estimated negative marginal costs for the KAL flights, thereby, unrealistic Lerner indices over the same time period. In this context, the nested logit structure may not suitably describe air travel demand of the Seoul-Busan route in that period. Thus, the OLS estimation results using the *Lerner* variable in Model 2 may also be inconsistent with the static profit maximization assumption. Thus, I will limit the analysis to Model (1) only.

[18] Time subscripts are omitted. The numbers are rounded.

Table 5.7: Descriptive statistics: Seoul-Busan route (r = 6)

6. Seoul-Busan route	Pre-deregulation				Post-deregulation			
Variable	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max
$BtwnDIFF$	0.9831	0.0069	0.9766	0.9931	0.9748	0.0010	0.9735	0.9780
HHI	0.5750	0.0399	0.4730	0.6120	0.5169	0.0363	0.4490	0.5910
Number of carriers	2.3	0.5	2.0	3.0	2.1	0.4	2.0	3.0
Flight frequency	30.1	1.9	26.9	35.2	29.7	1.8	27.5	33.2
Lerner indices	0.6348	0.0825	0.5068	0.8071	0.6262	0.1159	0.4853	0.8288
Load factor	0.7015	0.0524	0.5572	0.7734	0.6583	0.0697	0.5309	0.8060

In all 52 months observations, $BtwnDIFF$ is less than 1, and the values dropped in the post-deregulation period. It would indicate that the inter-firm differentiation is less than the overall differentiation between all flights on the Seoul-Busan route and carriers tend to schedule their flight times more closely to their rivals' flight over time. The Herfindahl indices decreased, indicating that the level of competition increased on the Seoul-Busan route. This preliminary evidence supports the statement that on average, carriers schedule their flight times more closely to their rivals' flight as the degree of competition increases with deregulation.

Average values for both the number of carriers and the route-wide total flight frequencies decreased since May 2008. *Lerner* slightly decreased, being more dispersed in the deregulated period. $Loadfactor$ declined as well, showing a larger standard deviation than in the pre-deregulation period. Compared to the Jeju island routes, the Seoul-Busan route recorded a relatively lower load factor with a smaller standard deviation. The less variation in $Loadfactor$ is not surprising because the inland routes attract a greater number of business travelers rather than vacationers, having less seasonality effect, thereby less cyclical variation.

Table 5.8: OLS estimation of log-log specification: Seoul-Busan route (r = 6)

6. Seoul-Busan route	Dependent variable Ln*BtwnDIFF*
Explanatory variable	Model (1)
LnHHI	0.0191*
	(0.009)
Deregulation	-0.0044*
	(0.002)
LnLoadfactor	0.0147**
	(0.005)
LnLerner	
LnFlight	0.0285*
	(0.012)
Number of carriers	0.0039
	(0.002)
Constant	-0.2209*
	(0.083)
N	52
adj. R-sq	0.472

Robust standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

As shown in the Table 5.8, the primary conclusions from summary statistics hold up in the OLS regression results for Model (1). The coefficient estimate for LnHHI is positive and significant at 5% level,[19]implying that carriers schedule their departure flight times closer to each other as competition increases on the route. The impacts of $Deregulation$ on the degree of inter-firm departure time differentiation are all negative as expected and robust across models.[20] This can be interpreted as support for a minimum differentiation incentive to steal customers as the degree of competition increases with deregulation.

Surprisingly, the coefficient estimate for Ln$Loadfactor$ is positive in Model (1) and statistically significant. I would expect to find negative effect of load factors on $BtwnDIFF$ due

[19]In order to see whether carriers strategically schedule their departure flight times either farther from or closer to their rivals' flight times, the null hypothesis that H_0 : The coefficient for $LnHHI$ is equal to zero (against the alternative hypothesis H_1 : The coefficient for $LnHHI$ is not equal to zero) was tested for Models (1). Based on the two-tailed t statistics, one can reject the null hypothesis.

[20]I tested the null hypothesis that H_0 : The coefficient for $Deregulation$ is equal to zero (against the alternative hypothesis H_1 : The coefficient for $Deregulation$ is either less than or equal to zero) given that inter-firm differentiation decreases with competition in the Seoul-Busan route. According to the one-tailed t-test statistics results, there is statistical evidence to reject the null hypothesis.

to a relatively low average load factors on the Seoul-Busan route (the inland route) compared to the Jeju island routes. In the absence of capacity constraints, the incentive to schedule departure flight times far from rivals' flights by means of a product differentiation strategy would be strengthened.

With regards to the impact of market structure on the degree of inter-firm departure time differentiation, both the departure flight frequency and the number of carriers are included. The coefficient estimates for Ln$Flight$ are all positive but less robust in Model (2). The more frequent flights, given a fixed number of carriers on the Seoul-Busan route, would predict a larger value of $BtwnDIFF$. The coefficient estimates for Ln$Carrier$ are negative, but the estimated impacts are not significant.

5.5 Conclusion: Scheduling Departure Flight Times

The results in chapter 5 contribute two new insights into the empirical study on the Korean airline industry. Given that there have been no studies on location competition in the Korean airline industry, empirical findings in this chapter would suggest important implications for future research. First, the model design differs from those in the U.S airline study in that it uses time-series data from June 2006 to October 2010 for each of four routes in the Korean airline industry, capturing the route-specific consequences caused by the May 2008 Deregulation Act. Second, I focus on the departure flight times differentiation scheduled by different airline carriers, not the flight times differentiation between all flights.[21]

Results presented in this chapter imply that the effects of competition on the degree of inter-firm departure times differentiation would have a different impact across the Jeju island routes and the inland route (Seoul-Busan route, r = 6). The econometric analysis

[21] For comparison, the empirical study on the strategic departure flight times scheduling behaviors in the U.S. airline industry suggested that the effect of competition on departure flight times differentiation was negative. This finding was based on pooled cross-section data across all routes (data from the Department of Transportation's Database 1A for the second quarter of 1986 in Netz & Borenstein (1999) or data from Airline Service Quality Performance's Database for May 2005 in Yetiskul (2010)).

provides a route-specific effect even with the Jeju island routes. For the Jeju-Cheongju route (r = 3) where the two legacy carriers competed with the independent LCC, the increase in competition level is associated with greater between firms differentiation. By contrast, this tendency is not found in the other two Jeju island routes (Jeju-Seoul route, r =1, and Jeju-Busan route, r = 2) where the two legacy carriers have diversified their strategies by establishing their own subsidiary LCCs. Rather, the degree of competition would appear to have no statistically significant effects for these routes. In the absence of dependent LCCs on the route, it can be said that the independent LCCs may try to differentiate their flight services from those of major airlines by means of maximum product differentiation.

On the other hand, for the Seoul-Busan route, r = 6, (the inland route), the degree of competition would be associated with less differentiation between carriers, and a stronger tendency is observed in the deregulated period. The inland routes are commonly known as business travelers' routes, with a concentrated demand for a few hours per day. The empirical finding appears to be consistent with this prior knowledge in that there will be less departure flight times differentiation between carriers on the Seoul-Busan route.

The results for both $Lerner$ and $Loadfactor$ are also not robust across routes. These findings would support that the route-specific profitability is related to the two opposing incentives: minimum differentiation and maximum differentiation. The answer to the primary question – which incentive outweighs the other – depends on specific circumstances (e.g., business travel route). Detailed estimation results are summarized in order: $Lerner$ and $Loadfactor$. The coefficients on both variables alternate in sign. On one hand, the positive effects of $Lerner$ on the between firm differentiation imply that the higher the profitability, the greater gap between carriers' flight times. Since the higher profitability is implied by the less elastic demand under the supply model specification (chapter 3), it strengthens the incentive for a carrier to schedule its departure flight times far from its rivals' flights, avoiding the potential loss from intensive price competition (i.e., cutting prices). On the other hand, the negative effects of $Lerner$ on the between firm differentiation imply that the minimum differentiation incentive may drive carriers to schedule their flight times closer to their rivals' flights, drawing off passengers from nearby flights.

In a similar way, $Loadfactor$ has both positive and negative effects across routes. The negative sign would indicate that high load factors lead to a minimum departure flight times differentiation between competitors when the demand tends to be concentrated into a few hours during a day. In other words, the higher the load factor, the less departure time differentiation between airlines. The positive effect of $Loadfactor$ on the between firm differentiation imply that the incentive to steal customers by locating their flight times closer to their rivals' flights would be reduced when the load factors are almost full. Thus, a higher load factor may lead to greater differentiation between carriers.

Chapter 6

Evaluating Deregulation and its Welfare Effects

The economic effects generated by the policy change, i.e., the May 2008 Deregulation Act, is the subject of this chapter. If significant welfare changes that accompany the Act are estimated, one may question how far it improved welfare for the two types of economic agents, consumers and producers, respectively. If there are no welfare changes, one carefully needs to investigate the major obstacles hindering benefits from the Act change.

The welfare measure in the discrete choice model starts from the definition of the market, thus, market size (chapter 2).[1] Recall that, for each market, each consumer is assumed to purchase only one product that gives the highest utility against all other alternatives including the non-buying option. This assumption appears to be suitable for service goods, e.g., air travel, so that one may calculate the magnitude of benefits from the introduction of new product to consumers with the demand estimates for each market. In the nested logit demand specification, particularly, gains from either product innovation or introduction of the new good is measured by comparing the size of aggregate consumers' utilities between two time periods.

[1] Profit changes are commonly known as the welfare measure for producers' surplus.

Market shares are defined using a quantity variable which depends on the context. The most important consideration in choosing the quantity variable is the need to define a market share for the outside good. For each non-stop route, I define a market as a city pair route in time t. Potential market size is defined as the number of passengers (the inside good) plus potential fliers making a no flight decision (outside good). This market varies across time and routes. All city pair routes of the Jeju island routes are flying to Jeju island, and those of the inland routes are flying to Seoul and vice versa. In our context, route- and time (month)-specific outside good shares are constructed to be proportional to origin city population. For example, monthly populations for Seoul, Busan, Cheongju, Daegu, and Gwangju are used for each city pair routes of the Jeju island routes, and in a similar manner, monthly populations for Busan and Gwangju are used for each pair routes of the inland routes.

The outside good market shares calculated from 0.01% to 0.5% of populations for origin cities flying to Jeju island range between 0.164% and 8.211% for the Jeju-Seoul route, 0.233% and 11.627% for the Jeju-Busan route, 0.006% and 3.192% for the Jeju-Cheongju route, 0.388% and 19.398% for the Jeju-Daegu route, and 0.213% and 10.667% for the Jeju-Gwangju route. The outside good market shares calculated from 0.01% to 0.5% of populations for origin cities flying inland range between 0.171% and 8.544% for the Seoul-Busan route, 0.295% and 14.736% for the Seoul-Gwangju route. The demand estimation results are qualitatively insensitive to the choice of time- and route-specific outside goods, at 0.01% to 0.5% of population for origin cities. That is, the choice of time- and route- specific outside goods only affect the size and significance level of airline carrier-specific fixed effects, and the relative size of the carrier-specific fixed effects does not change over the chosen percentages, 0.01% to 0.5%, of populations for origin cities. In our context, the welfare evaluation will proceed with the chosen percentage (0.1%) of populations for origin cities.

The development of accurate measures of the welfare gains from the introduction of new LCCs is the subject of this chapter. The primary interest of this paper is the effects of the May 2008 Deregulation Act in S. Korea on the entry of LCCs and any corresponding welfare improvement. In the post-deregulation period, restrictions imposed on independent LCCs were eliminated, thus enabling all LCCs to operate jet aircraft with more than 100 seats per plane, and allowing more freedom in scheduling frequent flights. Throughout the 52 months of observations, the entry of LCCs was limited to the routes either flying to Jeju island or having the two largest metropolitan areas – Seoul and Busan – as an end point city. Other than those routes, no entrants were observed in either the Jeju-Gwangju route (r = 5) or the Seoul-Gwangju route (r = 6). These two routes without any LCC entry might be comparison routes in a differences-in-difference (hereafter DD) model.[2] But in fact these routes are not a good comparison group under DD. I.e., the comparison group should not be affected by the treatment. For it to be accurate, a comparison group differences out other confounding factors that changed around the treatment, thereby isolating the treatment effect. As opposed to the comparison group, only the treatment group, which comprises the routes with LCC entry in our context, should have been subject to treatment of the May 2008 Deregulation Act. However, since the Act's changes are a nationwide policy, DD would not be plausible for our research design.[3]

With regard to estimating economic effects of the introduction of new products, the analysis of welfare consequences is split into two parts: benefits to consumers and benefits to producers. Given that dynamic behaviors of air passengers (demand side) and/or airline carriers (supply side) are not modeled under the current specification, I follow the welfare measurement approach widely used in static equilibrium models. According to an Italian yogurt study (Giacomo [2008]), the introduction of two new brands increased consumers' surplus, and the change in industry profits was negative.[4] In this study most of the consumer

[2]The DD identification strategy is a version of fixed effects estimation using aggregate data. See Card and Krueger [2000]. Card and Krueger studied the effect of the minimum wage on employment. In April 1992, New Jersey raised the state minimum wage from \$4.25 to \$ 5.05 while the minimum wage in Pennsylvania stayed at \$4.25. They compared the February to November change in employment in New Jersey to the change in employment in Pennsylvania over the same period.

[3]It may be arguable, if treatment effects on these two routes were negligibly small, one can use DD.

[4]At the end of February 2002, Yomo introduced two new brands. Total welfare increased by €30 million in 1 year after the introduction of the two new brands, while holding the market structure, i.e., number of brands, unchanged. Both consumers' welfare change and producers' variable profits change based on a yearly basis

welfare increase was due to the price reductions as a reaction to the new brands by all the main competitors. Similarly, Petrin [2002] also suggests that consumer benefits from the introduction of the minivan were large, and almost half of these benefits came from increased price competition. *A priori* one could expect that the introduction of a product/brand will lead to welfare enhancement for consumers, given that there is a reduction in prices. As shown in the chapter 4, however, the average prices for major airlines slightly increased in real terms, and average prices for independent LCCs either slightly decreased in the Jeju-Cheongju route or increased in the other two Jeju island routes in real terms after deregulation. With small variations in prices within carriers, one would expect to find less consumer benefits associated with post-deregulation entry of LCCs.

6.1 Computing Consumer Welfare Gains from Entry of LCCs

First, I estimate the change in consumer welfare from entry of LCCs on a particular route. Following the approach byTrajtenberg [1989] the point estimates for a nested logit demand model are used to evaluate the welfare gains associated with the entry of LCCs.[5] Changes in not only the set of available carriers in each time on the route, but also observed flight services attributes directly measure consumer surplus gains. In particular, improvements in the qualities of flight services for each carrier, i.e., daily flight frequency, aircraft size, and airtime duration, following the May 2008 deregulation of the airline industry are critical components in measuring consumer surplus gains along with the variation in prices for flight services.

One needs to compute the mean utility using the point estimates for prices and the observed characteristics between pre- and post- entry of LCCs. Welfare measurements based

are calculated, respectively.

[5]In his paper, he separately estimated the nested logit model for every year from 1976 to 1981, and then took differences between computed aggregate consumers' surplus in adjacent years, using the estimated demand coefficients for the observed characteristics and prices.

on a product characteristics approach simply aggregate consumer surplus in each time period, then take differences. The net consumer surplus, CS, measures the attractiveness of the set of J flights in monetary terms after taking into account the disutility from airfare ($\alpha > 0$, coefficient for Fare variable). Using the assumptions of the nested logit model, the route specific aggregate consumer surplus in each time moment t is

$$CS_t^r = \frac{v_{it}^r}{\alpha}$$

where v_{it}^r is route- and time-specific aggregate sum of the deterministic component of the indirect utility for individual air passenger i in time t ;

$v_{Jeju,it}^r = ln\left(\sum_g \left(\sum_{j\in g} exp\left(\frac{\delta_{Jeju,jt}^r}{1-\sigma_r}\right)\right)^{1-\sigma_r}\right)$ for the Jeju island routes,
and
$v_{Inland,it}^r = ln\left(\sum_g \left(\sum_{j\in g} exp\left(\frac{\delta_{Inland,jt}^r}{1-\sigma_r}\right)\right)^{1-\sigma_r}\right)$ for the inland routes.

Since the price sensitivity to price change is the same across all routes ($\alpha_{Jeju} = \alpha_{Inland} = \alpha$), but the nesting parameter σ_r and flight characteristics should be allowed to have different effects across all routes (chapter 2), $v_{Jeju,it}^r$ and $v_{Inland,it}^r$ need to be considered, respectively.

For the Jeju island routes, $v_{Jeju,it}^r = ln\left(\sum_g \left(\sum_{j\in g} exp\left(\frac{\delta_{Jeju,jt}^r}{1-\sigma_r}\right)\right)^{1-\sigma_r}\right)$ is the sum of indirect utilities for air passenger i from both the inside good ($g = 1$, i.e., air travel choice) and the outside good ($g = 0$, no-flying decision) as g represents the segment, nesting structure of air travel demand. Route-specific flights $j = 0, 1, ..., J$ are nested into two segments: Inside goods group $g = 1$ as one nest, and an outside good group $g = 0$ as another nest in which only the non-buying option, $j = 0$ is available.[6]

[6]The utility from the outside good $j = 0$ is normalized to zero, $\delta_{Jeju,0t}^r = 0$, thus, $v_{Jeju,it}^r = ln\left(\sum_g \left(\sum_{j\in g} exp\left(\frac{\delta_{Jeju,jt}^r}{1-\sigma_r}\right)\right)^{1-\sigma_r}\right) = ln\left(1+\left(\sum_{j\in g=1} exp\left(\frac{\delta_{Jeju,jt}^r}{1-\sigma_r}\right)\right)^{1-\sigma_r}\right)$.

Recall the following assumptions that are used to derive route-specific market share function, $s_{jt} = \frac{exp\left(\delta^r_{Jeju,jt}/1-\sigma_r\right)}{D_g^{\sigma_r}\left[\sum_g^{g=0,1} D_g^{(1-\sigma_r)}\right]}$:[7]

- Individuals' heterogeneity enters the model through the random part of utility $\left[\zeta^r_{igt} + (1-\sigma_r)\,\varepsilon_{ijt}\right]$.

- both ε_{ijt} and $\left[\zeta^r_{igt} + (1-\sigma_r)\,\varepsilon_{ijt}\right]$ follow a type I extreme value distribution.

- Individual consumer i chooses the flight j that maximizes utility.

These assumptions made the closed form market share function, thereby, demand for each flight j, only depend on flight characteristics, prices, and product level errors where $\delta^r_{Jeju,jt} = X^r_{Jeju,jt}\beta_r - \alpha p^r_{jt} + \xi_{jt}$ measures route specific mean utility levels for flight j for the Jeju island routes (demand equation (3)). The mean utility level differentiates flights, thus, the demand model can be estimated using market level prices and quantity data (no individual purchases data is required for the nested logit demand specification).

With regard to $\delta^r_{Jeju,jt}$, one can differentiate the marginal effect of price on utility (α) from the marginal effect of non-price factors, such as flight characteristics, on utility (β_r). In order to calculate the net utility for flight j, consumer welfare measure, CS^r_t, needs to be modified, i.e., dividing $v^r_{Jeju,jt}$ by α.

Then, incremental consumer surplus gains from the entry of LCCs occurring from t–1 to t can be calculated as follows:

$$\Delta CS^r(\%) = \frac{\left(CS^r_t - CS^r_{t-1}\right)}{CS^r_{t-1}} \times 100$$

or

$$\Delta CS^r = \frac{\left(v^r_{it} - v^r_{it-1}\right)}{\alpha}$$

[7]See chapter 2 for detailed derivation.

The same logic applies to the inland routes as well.

$v^r_{Inland,it} = ln\left(\sum_g \left(\sum_{j\in g} exp\left(\frac{\delta^r_{Inland,jt}}{1-\sigma_r}\right)\right)^{1-\sigma_r}\right)$ is the sum of indirect utilities for air passenger i from both the inside good ($g = 1$, i.e., air travel choice) and the outside good ($g = 0$, no-flying decision) as g represents the segment, nesting structure of air travel demand. Route-specific flights $j = 0, 1, ..., J$ are nested into two segments: Inside goods group $g = 1$ as one nest, and an outside good group $g = 0$ as another nest in which only the non-buying option, $j = 0$ is available. $\delta^r_{Inland,jt} = X^r_{Inland,jt}\beta_r - \alpha p^r_{jt} + \xi_{jt}$ measures route specific mean utility levels for flight j for the inland routes (demand equation (6)).

With regard to $\delta^r_{Inland,jt}$, one can differentiate the marginal effect of price on utility (α) from the marginal effect of non-price factors, such as flight characteristics, on utility (β_r). In order to calculate the net utility for flight j, consumer welfare measure, CS^r_t, needs to be modified, i.e., dividing $v^r_{Inland,jt}$ by α.

For the inland routes, incremental consumer surplus gains from the entry of LCCs occurring from t–1 to t can be calculated as follows:

$$\Delta CS^r(\%) = \frac{\left(CS^r_t - CS^r_{t-1}\right)}{CS^r_{t-1}} \times 100$$

or

$$\Delta CS^r = \frac{\left(v^r_{Inland,it} - v^r_{Inland,it-1}\right)}{\alpha}$$

6.2 Change in Producers' Surplus

Second, the changes in producers' surplus due to the entry of LCCs for both the entrant and pre-existing competitors are computed under two equilibrium concepts: the SBNE and the MBNE. The route- and time-specific variable profit Π^r_{jt} of a single-product firm j is given by:[8]

$$\Pi^r_{jt} = \left(p^r_{jt} - mc^r_{jt}\right) Ms_{jt}$$

where p^r_{jt} is the observed air fare, mc^r_{jt} is constant marginal cost, s_{jt} is the market share of flight j, and M is the market size.

The route- and time-specific variable profit of Korean Air operating two of the J flights in a route is as follow:

$$\Pi^r_{ft} = (p^r_{mt} - mc^r_{mt}) Ms_{mt} + (p^r_{lt} - mc^r_{lt}) Ms_{lt}$$

where p^r_{mt} is the observed air fare for KAL flight m, p^r_{lt} is the observed air fare for JNA flight l, mc^r_{mt} is constant marginal cost for KAL flight m, mc^r_{lt} is constant marginal cost for JNA flight l, s_{mt} is the market share of KAL flight m, s_{lt} is the market share of JNA flight l. M is the market size.

For each route, variable profits calculated from marginal cost estimates under each of the two supply side models, the SBNE and the MBNE, are reported in separate tables, respectively. The differences between pre- and post-entry variable profits are measured in monetary values (CPI-adjusted in 2005 year dollar) and percentage changes.

[8] Each airline carrier other than Korean Air is treated as single-product firms, each operating their own flights. For some routes, Asiana rebadged to Air Busan, but it never operated under both badges: AAR and ABL.

6.3 Route-by-Route Estimated Welfare Effects

6.3.1 An Inland Route: Seoul-Busan Route (r = 6)

Within inland routes, air travel demands for two routes (r = 6, 7) were estimated, respectively, in chapter 2: Seoul-Busan (r = 6) and Seoul-Gwangju (r = 7). The Seoul-Gwangju route has only been operated by the two legacy carriers, KAL and AAR. That is, KAL's multi-brand strategy and AAR's rebadging strategy were limited to the Seoul-Busan route: AAR rebadged to ABL in October - November 2008, and KAL started to fly under both KAL and JNA badges in January 2009. For the estimated welfare effects from the introduction of LCCs, thus, I will not focus on the Seoul-Gwangju route.

As seen in chapter 4, own-price elasticities were computed using the estimates for the demand specification and demand side variables, such as prices and market shares.[9] The estimates from demand equation (equation (6)) for the inland routes were used to compute route and time specific own- and cross-price elasticities. The empirical modeling strategy was to use the demand elasticity estimates to find markups and marginal costs under a SBNE (equation (7)) and the demand elasticity estimates and cross elasticity estimates between KAL and its LCC subsidiary JNA under a MBNE between January and March 2009 (jointly solving equations (8) and (9)). From these, the strategy was to then estimate changes in consumer surplus and producer surplus.

The methodology is to assume profit maximization in each time period and then using the relationships, $(p^r_{jt} - mc^r_{jt}) = \frac{p^r_{jt}}{\left|\eta^r_{jj,t}\right|}$ (7), for, for example, the SBNE where p_{jt} is in the data and $\eta^r_{jj,t}$ is from the demand estimation.

The maintained hypothesis of short run static profit maximization, however, can be rejected for the Seoul Busan route because the estimated elasticity in the pre-deregulation period (and periods prior to January 2009), $\left|\eta^r_{jj,t}\right|$ is less than 1 which implies the margin

[9]The formula for the own-price elasticity of flight j,
$\eta^r_{jj,t} = \left|\frac{p^r_{jt}}{s_{jt}}\frac{\partial s_{jt}}{\partial p^r_{jt}}\right| = \left|-\frac{\alpha}{1-\sigma_r} p^r_{jt}\left(1 - \sigma_r s_{jt/gt} - (1-\sigma_r)\, s_{jt}\right)\right|$ is derived under nested logit model.

$(p^r_{jt} - mc^r_{jt}) > p^r_{jt}$ or $mc^r_{jt} < 0$, which is certainly not the case. The implied CS^r_t for the pre-deregulation time period cannot be estimated in this case so the change in CS^r_t cannot be estimated.

Why is this the case? Probably this is related to the functional form for the demand estimation based on nested logit. Under the nested logit specification demand elasticities are proportional to either price, p^r_{jt}, or market share through $\frac{\left(1-\sigma_r s_{jt/gt}-(1-\sigma_r)s_{jt}\right)}{1-\sigma_r}$. In Seoul-Busan route KAL had a dominant market share of around 80% in the pre-deregulation period (and periods prior to January 2009). Given that the two legacy carriers, KAL and AAR, charged almost same prices to their flights (Table 4.11 in chapter 4), KAL's dominant market share may force its own-price elasticities to be small, even less than 1 which implies the estimated negative marginal costs over the same time periods.

Since JNA was the only entry (January 2009) in the Seoul-Busan route throughout the 52 months,[10] no estimated welfare effects analysis is available for the inland routes.

[10]Prior to the entry of JNA in January 2009, the KAL flights were estimated to have inelastic demand ($\eta^{Seoul-Busan}_{KAL,KAL,2008Dec} = 0.0.894$ with a dominant market share of 79%).
The AAR's rebadging strategy to ABL in October 2008, i.e., replacing its prior service with ABL, does not constitute a new entry.

6.3.2 Jeju Island Routes

As seen in previous section, the current nested logit model may not suitably describe the air travel demand structure of the Seoul-Busan (an inland route), at least, prior to the deregulation period.[11] Since the functional form of the average price elasticities are designed to depend on market shares for the outside good (no flying decision) as well as market shares for the inside good (air travel decision),[12] the KAL flights' dominant market share may lead to unrealistically small own-price elasticities.

On the other hand, this empirical specification may well capture the right demand structure for the Jeju island routes in that the current nesting structure may fail for routes with a dominant firm (e.g., KAL for the Seoul-Busan route in the pre-deregulation period).[13] Given that no such a dominant firm is observed in the Jeju island routes, and the estimates results in chapters 2 and 4 satisfy the two maintained hypotheses, either the nested logit or the short run profit max assumptions, we proceed using the demand and supply estimates in this chapter.

6.3.2.1 Jeju-Seoul Route (r = 1)

Table 6.1 shows the estimated change in the Jeju-Seoul route air passengers' welfare from the entry of LCCs in order: HAN in Oct 2006, ONA and JNA in July 2008, ESR in Jan 2009, and TWB in Sep 2010.

[11]The nesting structure would not suitably describe the air travel demand of the Seoul-Gwangju route (r = 7) as well. Throughout the 52 months observation, Seoul-Gwangju route had been operated by the two legacy carriers, and AAR was a dominant firm.

[12]The larger market shares for the outside good imply that passengers would substitute towards the outside good when all prices for flights (the inside good) are increased.

[13]*A priori* Jeju island routes are expected to differ from the inland routes from two perspectives: Alternative transportation modes and types of travelers. The domestic city pair traveling on inland routes may be undertaken using alternative travel modes such as rail or bus service, whereas there is no closely comparable ferry service to Jeju island. And with respect to the types of travelers, Jeju island routes are primarily for vacation travelers, while inland routes attract a great numbers of business travelers. Given that passengers would not easily find alternative transportation modes when overall prices for flights are increased, particularly for the Jeju island routes, a small size of the market share for the outside good are reasonable choices in our analysis (for example, the average market share for the outside good in yogurt industry study equals 99% in Giacomo, 2008).

Table 6.1: Consumers' surplus change: Jeju-Seoul route (r = 1)

1. Jeju - Seoul	Entry before-deregulation		Entries after-deregulation					
time	t-1 = Sep 2006, t = Oct 2006		t-1 = Jun 2008, t = Jul 2008		t-1 = Dec 2008, t = Jan 2009		t-1 = Aug 2010, t = Sep 2010	
Entry in time t	HAN Independent LCC		ONA Independent LCC	JNA Dependent LCC	ESR Independent LCC		TWB Independent LCC	
Total CS change	-0.784%	-US$19,174,246	-5.359%	-US$141,490,410	-0.001%	-US$24,892	1.943%	US$49,918,006

The point estimates from the demand model suggest that the TWB entry benefited air passengers, while the two other post-deregulation entries did not. One potential explanation for this may stem from fuel surcharges. After the point when the two legacy carriers started to impose fuel surcharges on all domestic routes in July 2008 and all remaining LCCs imposed fuel surcharges in August 2008, the entry of LCCs did not lead to a reduction in air fares for all carriers. From July 2008 to January 2009, the exceptionally high fuel surcharges raised airfares. Since the same sensitivity with respect to price within the Jeju-Seoul route across times is assumed, the rise in airfares would generate greater disutility for passengers when overall prices are higher than other time periods.

Table 6.2 shows the estimated change in variable profits for the Jeju-Seoul route before and after the change in deregulation policy. The second column illustrates how the entry of LCCs in the pre-deregulation period affected both industry-wide profits and an entrant's own profit, while the rest (columns 3 through 5) describe the effects of entry of LCCs in the post-deregulation period on profits. The values in the fourth row report the estimated industry-wide profit changes in response to each of the entries. The estimated changes in the profits of all main competitors - both the two major airlines and pre-existing LCCs – and the total variable profits of the introduced LCCs are reported in the cell below the fourth row (rows 5-12).

Table 6.2: Producers' surplus change under SBNE: Jeju-Seoul route (r = 1)

1.Jeju-Seoul	Entry before-deregulation		Entries after-deregulation					
time	t-1 = Sep 2006, t = Oct 2006		t-1 = Jun 2008, t = Jul 2008		t-1 = Dec 2008, t = Jan 2009		t-1 = Aug 2010, t = Sep 2010	
Entry in time t	HAN Independent LCC		ONA Independent LCC	JNA Dependent LCC	ESR Independent LCC		TWB Independent LCC	
Total profits change	0.336%	US$1,079,648	-6.514%	-US$17,707,955	-5.841%	-US$13,659,450	-3.876%	-US$8,068,950
KAL	2.332%	US$5,545,552	-12.027%	-US$21,031,104	-11.199%	-US$13,528,879	-15.253%	-US$13,870,969
AAR	-9.950%	-US$7,490,897	-6.032%	-US$4,580,517	-14.606%	-US$10,945,536	-2.889%	-US$1,219,209
HAN	Entry	US$2,890,493	17.757%	US$1,533,947	Exit		Exit	
JJA	1.618%	US$134,501	34.725%	US$4,307,264	-2.119%	-US$540,548	5.948%	US$1,076,950
ONA	N/A		Entry	US$76,963	Exit		Exit	
JNA	N/A		Entry	US$1,985,492	33.657%	US$4,238,594	0.635%	US$168,541
ESR	N/A		N/A		Entry,	US$7,116,919	6.800%	US$2,065,305
TWB	N/A		N/A		N/A		Entry	US$3,710,432

In Oct 2006, independent LCC, HAN, entered the Jeju-Seoul route, generating a slight gain for the estimated producers' surplus. HAN benefited from entering the route, gaining \$2.8 million in the first month. On the contrary, the estimated change in industry profits induced by the post-deregulation entry of LCCs is rather negative. It decreased by \$17 million (-6.5%) following the entries of ONA and JNA in July 2008. Over the same time period, the estimated variable profits for the two legacy carriers, KAL and AAR, decreased by 12% and 6% respectively, while two other independent LCCs reaped larger profit gains in percentages, 17.8% for HAN and 34.7% for JJA (column 3). The entry of ESR in Jan 2009 lowered the estimated industry profits by \$13 million in 1 month (-5.8%) (column 4). A sharp drop in the two legacy carriers' estimated variable profits was reported as a result of ESR's entry. The estimated variable profits for JNA, KAL's subsidiary LCC, increased by 33.6%, but it did not outweigh the estimated loss in the two legacy carriers' profit changes. Similarly, the entry of TWB in Sep 2010 lowered the estimated industry profits by \$ 8 million in 1 month (-3.8%) (column 5). The new entrant, TWB, benefited from entering the route, but the estimated losses in the two legacy carriers were sizable. Results suggest that the estimated profit gains obtained by a new carrier were not enough to offset the negative effects on the estimated industry-wide profits in the post-deregulation period.

Table 6.3: Producers' surplus change under MBNE: Jeju-Seoul route (r = 1)

1.Jeju-Seoul	Entry before-deregulation		Entries after-deregulation					
time	t-1 = Sep 2006, t = Oct 2006		t-1 = Jun 2008, t = Jul 2008		t-1 = Dec 2008, t = Jan 2009		t-1 = Aug 2010, t = Sep 2010	
Entry in time t	HAN Independent LCC		ONA Independent LCC	JNA Dependent LCC	ESR Independent LCC		TWB Independent LCC	
Total profits change	0.336%	US$1,079,648	-4.264%	-US$11,591,607	-3.153%	-US$8,344,725	-6.569%	-US$16,801,249
KAL	2.332%	US$5,545,552	-9.703%	-US$16,966,963	-7.766%	-US$10,875,251	-16.440%	-US$19,448,002
AAR	-9.950%	-US$7,490,897	-6.032%	-US$4,580,517	-14.606%	-US$10,945,536	-2.889%	-US$1,219,209
HAN	Entry	US$2,890,493	17.757%	US$1,533,947	Exit		Exit	
JJA	1.618%	US$134,501	34.725%	US$4,307,264	-2.119%	-US$540,548	5.948%	US$1,076,950
ONA	N/A		Entry	US$76,963	Exit		Exit	
JNA	N/A		Entry	US$4,037,699	28.509%	US$6,899,690	-6.388%	-US$2,986,725
ESR	N/A		N/A		Entry	US$7,116,919	6.800%	US$2,065,305
TWB	N/A		N/A		N/A		Entry	US$3,710,432

The estimated profit changes using the implied marginal costs on flight services under MBNE are presented in Table 6.3. Column 2 remained the same as in Table 6.2, since KAL's multiproduct firm activity, i.e., flying under both KAL and JNA badges, was limited to the post-deregulation period. Compared with Table 6.2, columns 3-5 in Table 6.3 only differ in the estimated values of KAL and JNA. The estimates in Table 6.3 suggest that columns 3 and 4 report less of a profit loss (in absolute value) for KAL and larger profit gains for JNA than the estimates of Table 6.2. On the contrary, column 5 shows the opposite: a larger profit loss for KAL and a profit loss for JNA, as well.

In summarizing the estimated changes in consumer and producer welfare for the two time periods, pre- and post- deregulation, results support that not all entries of LCCs following the Deregulation Act benefited consumers significantly. It appears that the estimated total producer surplus for the industry fell in the post-deregulation period. The absolute size of the estimated welfare gain/loss corresponding to each entry was far larger for the consumer side. The entry of LCC, HAN, in the pre-deregulated period is estimated to lower total welfare by $18 million in 1 month. The sum of the estimated incremental total welfare changes following each of the post-deregulation entries, ONA, JNA, ESR, and TWB, is negative under both equilibrium models: Total welfare loss of $131 million under the SBNE and total welfare loss of $128 million under the MBNE.

6.3.2.2 Jeju-Busan Route (r = 2)

Table 6.4 describes the estimated incremental consumer surplus changes from the entry of LCCs in order: JJA in Aug 2006, ONA in July 2008, and JNA in Apr 2009. The entry before-deregulation, JJA, was estimated to have no significant welfare effects on travelers. The estimated results imply that, on the other hand, the two LCCs that entered in the post-deregulation period led to sizable welfare effects on the consumer side. Dependent LCC, JNA, substantially benefited air passengers, while independent LCC, ONA, had the opposite effect.

Table 6.4: Consumers' surplus change: Jeju-Busan route (r = 2)

2. Jeju - Busan	Entry before-deregulation		Entries after-deregulation			
time	t-1 = Jul 2006, t = Aug 2006		t-1 = Jun 2008, t = Jul 2008		t-1 = Mar 2009, t = Apr 2009	
Entry in time t	JJA Independent LCC		ONA Independent LCC		JNA Dependent LCC	
Total CS change	0.108%	US$123,289	-18.476%	-US$25,376,131	7.680%	US$9,860,228

Table 6.5: Producers' surplus change under SBNE: Jeju-Busan route (r = 2)

2. Jeju-Busan	Entry before-deregulation		Entries after-deregulation			
time	t-1 = Jul 2006, t = Aug 2006		t-1 = Jun 2008, t = Jul 2008		t-1 = Mar 2009, t = Apr 2009	
Entry in time t	JJA Independent LCC		ONA Independent LCC		JNA Dependent LCC	
Total profits change	1.277%	US$1,864,242	-14.138%	-US$16,103,235	-18.839%	-US$16,853,458
KAL	1.997%	US$2,547,905	-21.320%	-US$19,885,051	-35.873%	-US$22,509,220
AAR	-6.495%	-US$1,194,255	11.042%	US$1,745,200	Rebadged to ABL in Dec 2008	
JJA		US$510,592	36.512%	US$1,763,161	-31.447%	-US$2,879,323
ONA	N/A		Entry	US$273,456	Exit	
ABL	N/A		N/A		-10.376%	-US$1,821,924
JNA	N/A		N/A		Entry	US$10,357,008

Table 6.5 (Table 6.6) reports the estimated change in variable profits implied by the SBNE (the MBNE) for the Jeju-Busan route before and after the change in deregulation policy. The second column illustrates how the entry of an LCC in the pre-deregulation period affected both the estimated industry-wide profits and an estimated entrant's own profit, while the rest (columns 3 and 4) describe the effects of entry of LCCs in the post-deregulation period on the estimated profits. The values in the fourth row provide the estimated industry-wide profit changes in response to each of the entries. The estimated changes in the profits of all main competitors – both the two major airlines and pre-existing LCCs – and the total variable profits of the introduced LCCs are presented in the cell below the fourth row (rows 5-10).

Table 6.6: Producers' surplus change under MBNE: Jeju-Busan route (r = 2)

2. Jeju-Busan	Entry before-deregulation		Entries after-deregulation			
time	t-1 = Jul 2006, t = Aug 2006		t-1 = Jun 2008, t = Jul 2008		t-1 = Mar 2009, t = Apr 2009	
Entry in time t	JJA Independent LCC		ONA Independent LCC		JNA Dependent LCC	
Total profits change	1.277%	US$1,864,242	-14.138%	-US$16,103,235	17.583%	US$15,730,394
KAL	1.997%	US$2,547,905	-21.320%	-US$19,885,051	-4.603%	-US$2,888,566
AAR	-6.495%	-US$1,194,255	11.042%	US$1,745,200	Rebadged to ABL in Dec 2008	
JJA		US$510,592	36.512%	US$1,763,161	-31.447%	-US$2,879,323
ONA	N/A		Entry	US$273,456	Exit	
ABL	N/A		N/A		-10.376%	-US$1,821,924
JNA	N/A		N/A		Entry	US$23,320,206

In Aug 2006, independent LCC, JJA, entered the Jeju-Busan route. The entry of JJA was estimated to increase the industry wide profit gains by 1.3%. JJA benefited from entering the route, gaining $0.5 million in the first month at the expense of AAR's estimated profit loss of 6.4%. On the contrary, the estimated changes in industry profits induced by the post-deregulation entry of LCCs differ across each of the two entries.

First, it decreased by \$16 million (-14.1%) following the entry of ONA in July 2008. The estimated results suggest that ONA recorded \$0.3 million of profit in the first month, while KAL, the largest legacy carrier, lost profits of \$20 million. Over the same time period, the estimated variable profits for AAR, the second largest legacy carrier, increased by \$1.7 million (11%). JJA reaped larger profit gains in percentages of 36.5%, and \$1.7 million in monetary values (column 3). Second, the effects from the introduction of JNA in Mar 2009 are measured to be different according to the equilibrium concepts: the SBNE and the MBNE. Under the SBNE, JNA was estimated to lower industry profits by \$16.8 million in 1 month (-18.8%), and a sharp drop in all main competitiors' estimated variable profits was reported as a result of JNA's entry (column 4 in Table 6.5). Compared with Table 6.5, columns 4 in Table 6.6 only differ in the values of KAL and JNA. Again, the estimated effect of the entry of JNA on all main competitiors' variable profits was negative, but the estimated gain for JNA outweighed the estimated loss in the remaining rivals, thus, increasing the estimated industry wide profit gain (column 4 in Table 6.6).

On the Jeju-Busan route, the entry of LCC, JJA, in the pre-deregulated period is estimated to improve the total welfare by \$1.9 million. The sum of the estimated incremental total welfare changes following each of the post-deregulation entries, ONA and JNA, is negative under both equilibrium models: Total welfare loss of \$48.5 million under the SBNE and total welfare loss of \$15.9 million under the MBNE.

6.3.2.3 Jeju-Cheongju Route (r = 3)

Table 6.7 describes how air passengers on the Jeju-Cheongju route benefited from the post-deregulation entry of the independent LCCs in order: JJA in June 2008, and ESR in June 2009. The post-deregulation entry of the two independent LCCs was estimated to increase consumers' surplus gains.

Table 6.7: Consumers' surplus change: Jeju-Cheongju route (r = 3)

3. Jeju - Cheongju	Entry before-deregulation	Entries after-deregulation	
time	None	t-1 = May 2008, t = Jun 2008	t-1 = May 2009, t = Jun 2009
Entry in time t		JJA Independent LCC	ESR Independent LCC
Total CS change		1.921% US$1,664,513	2.481% US$2,200,021

Table 6.8 reports the estimated change in variable profits for the Jeju-Cheongju route after the change in deregulation policy. The columns 3 and 4 present the estimated effects of entry of LCCs in the post-deregulation period on profits. The values in the fourth row correspond to the estimated industry-wide profit changes in response to each of the entries. Changes in the estimated profits of all main competitors – both the two major airlines and pre-existing LCCs – and the estimated total variable profits of the introduced LCCs are reported in the cell below the fourth row (rows 5-9).

Table 6.8: Producers' surplus change under SBNE: Jeju-Cheongju route (r = 3)

3. Jeju - Cheongju	Entry before-deregulation	Entries after-deregulation			
time	None	t-1 = May 2008, t = Jun 2008		t-1 = May 2009, t = Jun 2009	
Entry in time t		JJA Independent LCC		ESR Independent LCC	
Total profits change		-5.056%	-US$1,282,875	-7.900%	-US$2,033,261
KAL		-7.420%	-US$939,377	-14.746%	-US$1,957,903
AAR		-9.843%	-US$979,854	-12.527%	-US$1,226,921
HAN		-12.225%	-US$337,461	Exit	
JJA		Entry	US$973,818	-7.737%	-US$206,120
ESR		N/A		Entry	US$1,357,684

In June 2008, JJA entered the Jeju-Cheongju route, leading to losses in the estimated industry wide profit of \$1.3 million. JJA benefited from entering the route, gaining \$0.9 million in the first month at the expense of all the competing carriers, KAL's loss in estimated profits of 7.4%, AAR's loss in estimated profits of 9.8%, and HAN's loss in estimated profits of 12.2%. Similarly, ESR decreased the estimated industry wide profits by \$2 million (-7.9%) in June 2009, recording \$1.4 million of estimated profit in the first month at the expense of all the competing carriers. On the Jeju-Cheongju route, the sum of the estimated incremental total welfare gains due to entry of the independent LCCs in the post-deregulation period, JJA, and ESR, is \$0.5 million. It appears that consumers' welfare gains due to new entrants outweigh the losses in producers' surplus.

6.3.2.4 Jeju-Daegu Route (r = 4)

Table 6.9 reports the estimated change in consumers' surplus on the Jeju-Daegu route from the post-deregulation entry of the independent LCC, ONA in July 2008. The estimated effect of the entry of ONA on aggregate air passengers is negative. One needs to be careful in interpreting the result since July 2008 is the point when the two legacy carriers started to impose fuel surcharges on all domestic routes, thereby, the overall prices for flight services rose sharply.

Table 6.9: Consumers' surplus change: Jeju-Daegu route (r = 4)

4. Jeju - Daegu	Entry before-deregulation	Entries after-deregulation
time	None	t-1 = Jun 2008, t = Jul 2008
Entry in time t		ONA Independent LCC
Total CS change		-5.845% -US$37,499,549

The introduction of fuel surcharge is also associated with a slight drop in the estimated industry wide variable profits for the Jeju-Daegu route in the post-deregulation period (row 4 in Table 6.10). The rows 5-7 in column 3 in Table 6.10 provides the estimated changes in variable profits for each individual airline carrier as well. In July 2008, independent LCC, ONA, entered the Jeju-Daegu route, gaining only \$0.3 million in the first month. The small size of the estimated profit gains for the entrant was not enough to outweigh the estimated losses in the two legacy carriers, thus, yielding larger losses for the estimated industry wide profits. Finally, the estimated total welfare decreased by \$38.1 million following the entry of ONA.

Table 6.10: Producers' surplus change under SBNE: Jeju-Daegu route (r = 4)

4. Jeju - Daegu	Entry before-deregulation	Entries after-deregulation	
time	None	t-1 = Jun 2008, t = Jul 2008	
Entry in time t		ONA Independent LCC	
Total profits change		-0.752%	-US$601,065
KAL		-0.140%	-US$67,420
AAR		-2.536%	-US$804,519
ONA		Entry	US$270,874

6.4 The Estimated Welfare Effects: Conclusion

Chapter 5 evaluates the welfare gains due to the entry of LCCs for two time periods: pre- and post-deregulation. *A priori* the welfare consequences of new entrants into markets can be predicted under current static models, the demand side (chapter 2) and the supply side (chapter 3). Regarding the former model (demand), the coefficients for the non-price factors, such as flight frequency, aircraft size, and flight time duration, are estimated to have larger effects (in absolute size) on consumers' utilities from flight services than the point estimates for the price variable. Unexpectedly rising oil prices and fuel prices led airline carriers to introduce fuel surcharges on top of their list prices for flight services since July 2008, just two months after the May 2008 Deregulation Act. If the positive effects from improvement in non-price factors, e.g., flight service qualities, outweigh the negative effects from the rise in price, the post-deregulation entry of LCCs could still enhance consumer welfare. As seen in the latter model (supply), the average Lerner indices and market shares far increased for the established independent LCCs in the routes without competitive dependent LCCs. The flight services of the independent LCCs, either successfully restructured by expanding its capacities after the deregulation or starting its business after the deregulation, could increase consumers' surplus.

The empirical findings in this chapter provide evidence of the welfare losses in the post-deregulation on some routes. The estimated welfare effects for the consumer side and the producer side are computed, respectively. The welfare calculations imply that a sizable consumer welfare improvement is associated with the intensified competition from entry of the successful independent LCCs only when no legacy carriers have responded with their own subsidiary LCCs. The post-deregulation entry of LCCs from June 2008 to January 2009 (the unexpectedly high fuel surcharge period) benefited neither the consumer side nor the industry-wide producer side. The results support that the more gains for the new entrant, the less loss in the two legacy carriers, thereby, less industry-wide profit loss.

The two equilibrium concepts, SBNE and MBNE, have drastically different effects on the estimated producers' surplus gains within the routes. Given that the maintained hypothesis of short run profit maximization can be rejected for the Seoul Busan route, neither change in CS nor PS due to an entry (prior to January 2009) can be estimated for the inland routes.[14] For the Jeju island routes, the MBNE is designed to have larger variable profits for KAL and JNA through multiproduct activities than those of the SBNE, when the entry of LCC occurred during peak seasons: April (JNA, April 2009, on the Jeju-Busan route), July (ONA and JNA, July 2008, on the Jeju-Seoul route), and January (ESR, January 2008, on the Jeju-Seoul route). In contrast, the opposite applies to the entry of an LCC during the off-peak-season (TWB, September 2010, into the Jeju-Seoul route).

These differences may arise from the time-varying prices. For the same route served by the same airline carrier, fares are lower during off-peak seasons than during peak-seasons. Peak-seasons also can be categorized into two types: August, and the semi-peak months of January, April, May, July and October.[15] The pricing equation under the MBNE is designed to predict a higher markup (thereby, a lower marginal cost) by the multiproduct firm-specific markup term than the SBNE. Furthermore, the markup gaps between the two concepts would be greater during the peak-season due to higher peak-season air fares. Combining the higher air fares and larger markups, the MBNE would lead to larger profits for KAL and JNA during peak-season.

The following limitations apply to the welfare measurements used in this chapter. First, if the estimates from the demand side are biased, the welfare calculations are biased as well.[16] This is clear because the point estimates from the demand specification are used to recover the implied price-cost margins, thus marginal costs for each carrier-time-route observation. Second, the standard nested logit demand model tends to overestimate the gains from a new

[14] See section 4.1.2 and 6.3.1.

[15] January (Korean New Year) and October (Korean Thanksgiving Day) are holiday season. July and August are summer vacation/tourist season. Elementary schools, middle schools, and high schools schedule educational field trips in April and May.

[16] See section 6.3.1 Seoul-Busan route results.

product, in particular, when producers introduce a similar brand with respect to product characteristics into a market. Third, neither dynamic responses, e.g., when and what route to enter or expand flight capacities, nor inter-temporal profit maximizing decisions are modeled here. Thus, it may not capture the dynamic nature of entry/exit competition.

Appendix

Description of airline carriers

Table 11: Description of airline carriers

Airline	Characteristics
Korean Air (KAL)	Major Airline, the parent company of JNA
Asiana Air (AAR)	Major Airline, the parent company of ABL
Hansung Air (HAN)	Low cost carrier (LCC)
Jeju Air (JJA)	LCC
Youngnam Air (ONA)	LCC
Jin Air (JNA)	LCC
Air Busan (ABL)	LCC
Eastar Jet (ESR)	LCC
T'way Air (TWB)	LCC, Hansung Air (HAN):re-launches service under new name.

- Korean Air (KAL) is the largest airline of South Korea, with global headquarters located in Seoul, Korea. Korean Air is among the top 20 airlines in the world in terms of passengers carried and is also the top ranked international cargo airline. Korean Air is a founding partner airline of SkyTeam, the world's second largest airline alliance. Its main rival is Asiana Airlines, the second largest South Korean carrier. Korean Air is a major airline carrier.

- Asiana Air (AAR) is one of South Korea's two major airlines, along with Korean Air.

Asiana Air is one of the seven airlines to be ranked as a 5 star airline by the independent research consultancy firm Skytax. Asiana is a major airline carrier.

- Hansung Airlines (HAN) arouse out of a collaboration between the city of government of Cheongju and the University of Chungcheong in 2004. In 2005, Hansung Air received its AOC, thus formally approved with the delivery of ATR-72, turboprop aircraft which has less than 100 seats per plane. On 19 December 2005, Hansung Air suspended all services due to budgetary constraints. On 15 February 2006, flights could be resumed, but financial difficulties remained, resulting in the shut-down in November 2008. Hansung Airline is an independent LCC.

- Jeju Air (JJA) is an airline based in Jeju, South Korea, offering scheduled domestic services between Jeju and the South Korean mainland. Jeju Air was established in January 2005 and began operations on June 2006. It is owned by the Aekyung Group (75%) and the Jeju Provincial Government (25%). As of November 2010, the Jeju Air fleet consists of Jet aircraft. However, in 2005, the airline placed an order for 5 Dash 8-Q400s, turboprop aircraft and these aircraft remained in the fleet for a short time period, then the last one was withdrawn on June 2010. Jeju Air is an independent LCC.

- Yeongnam Air (ONA) was a small regional airline of South Korea launched in July 2008. Its main base was Busan airport and Daegu airport. It flew to Jeju and Seoul with a single aircraft, Fokker100, 100-seat aircraft. Yeongnam Air (ONA) stopped its operations in December 2008. Yeongnam Air is an independent LCC.

- Jin Air (JNA) is a low cost airline of South Korea. It is a full subsidiary of Korean Air (KAL), the largest airline in Korea. Jin Air began operations in July 2008 with Boeing 737s, Jet aircraft, with 189 seats from Korean Air (KAL). Jin Air is a dependent LCC.

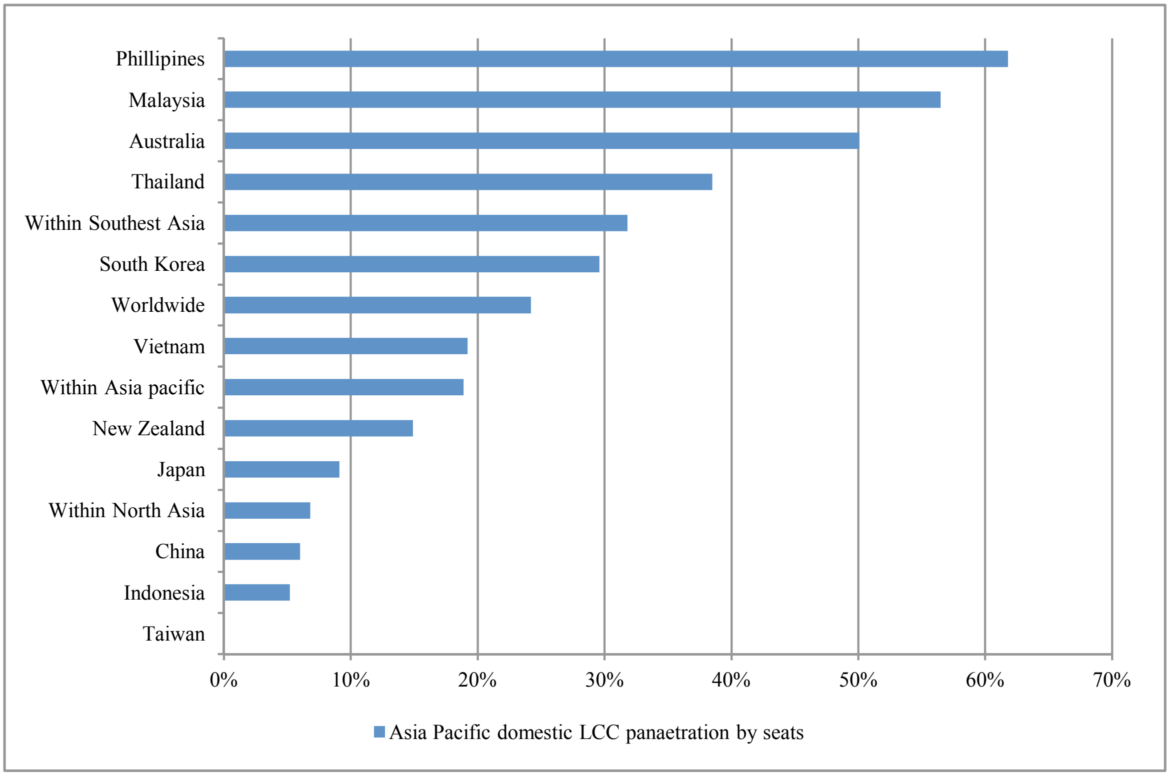
- Air Busan (ABL) is a regional airline with its headquarters in Busan, the second largest metropolis after Seoul in Korea and the fifth largest port in the world. Air Busan is a subsidiary of Asiana Air (AAR) and it launched service on October 2008. Since the launch on the Seoul-Busan route, Air Busan filled 49.7% of its seats, while its competitor on the same route, Korean Air (KAL) had 61.2%. About 5 months later in March 2009, however, Air Busan (ABL)'s boarding rate exceeded that of its competitor, 54.7% to 54.1%. For the Busan-Jeju route, Air Busan is also taking the lead, filling 77.7% of its seats. It has code-share operation with its parent company Asiana Air (AAR) for the two routes. Air Busan is a dependent LCC.

- Eastar Jet (ESR) is a scheduled low cost airline based in Seoul, South Korea. Eastar Jet started operations in October 2008. The main share holder of Eastar Jet is the Eastar group in South Korea. Eastar Jet is a regional airline, being organized to take advantage of a specific gap, low cost services out of hub airports, i.e., Seoul and Jeju, in the short-haul domestic travel market. Fortunately, Eastar Jet recorded the highest Load Factor (about 86%) 2009 in the Seoul-Jeju route among all airlines including two major carriers, Korean Air and Asiana Air. Eastar Jet is an independent LCC.

- T'way Air (TWB) is a scheduled low cost carrier, offering flights between Seoul and Jeju island. T'way Air was initially established in 2005 as Hansung Air (HAN), which launched services with three ATR-72s, turboprop aircraft (less than 100 seats per plane). In October 2008, continuing financial difficulties resulted in shut-down of Hansung Air (HAN). Finally, the airline was formally re-launched in September 2010 under the changed new name, T'way Air. After its first delivery of a Boeing 737-800 jet aircraft (about 180 seats per plane) in September 2010, the T'way fleet consists of four Boeing 737-800 aircraft as of September 2011. T'way Air is an independent LCC.

Figure 1: Korea's geographical features

Figure 2: Asia Pacific domestic LCC penetration by capacity (seats): Seven months to Jul-2011



For the other inland routes that were not included data set, no significant changes in the number of flights are observed. Flights tend to evenly scheduled over either morning cluster or evening cluster in the post-deregulation period.

Table 12: Average cluster differentiation index by route (for other inland routes)

Route	Pre-deregulation (before May 2008)			Post-deregulation (after May 2008)		
	Morning DIFF # of flights	Lunch DIFF # of flights	Evening DIFF # of flights	Morning DIFF # of flights	Lunch DIFF # of flights	Evening DIFF # of flights
Seoul-Yeosu	0.573 1.9	0.974 4.0	0.544 2.1	0.334 1.9	0.937 4.0	0.601 2.0
Seoul-Ulsan	0.587 2.8	0.976 5.0	0.982 5.0	0.686 3.3	0.906 4.2	0.964 5.0
Seoul-Jinju	0.000 1.0	0.000 0.0	0.893 2.0	0.000 1.0	0.000 0.0	0.849 2.0
Seoul-Pohang	0.521 1.6	0.840 2.3	0.000 0.3	0.359 1.6	0.528 2.3	0.478 0.3

# of flights are rounded.

Fuel surcharge and enplanements trend

Figure 3: Average monthly fares (in US $) and enplanements: Jeju-Busan route (r = 2)

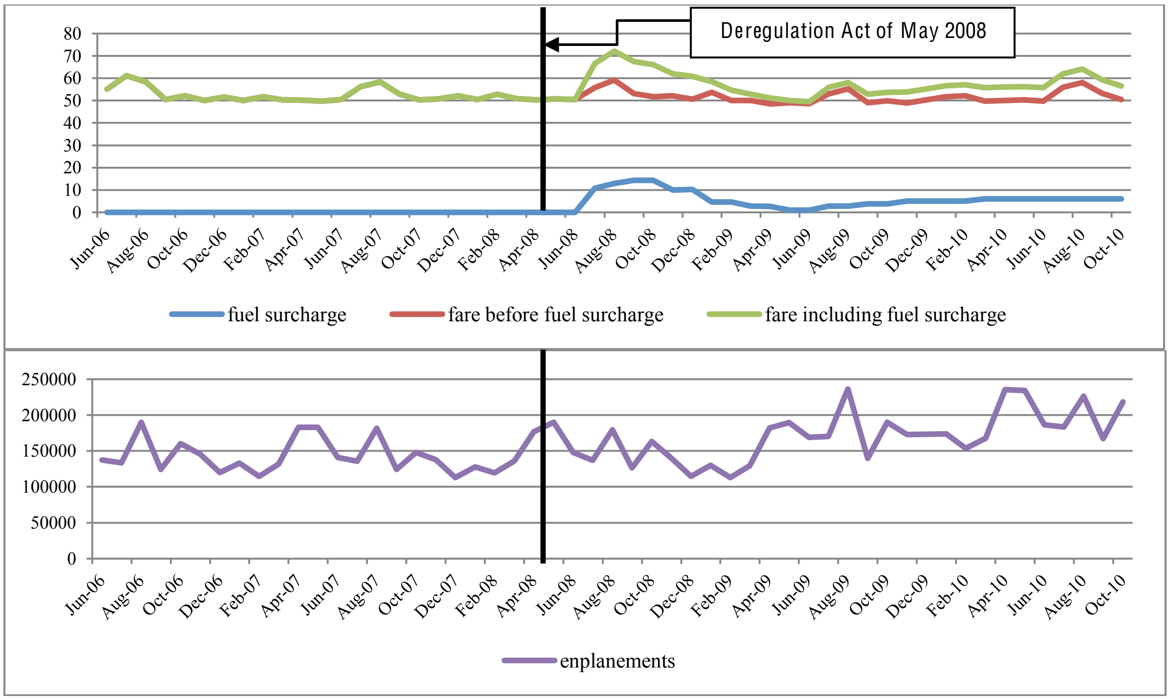


Figure 4: Average monthly fares (in US $) and enplanements: Jeju-Cheongju route (r = 3)

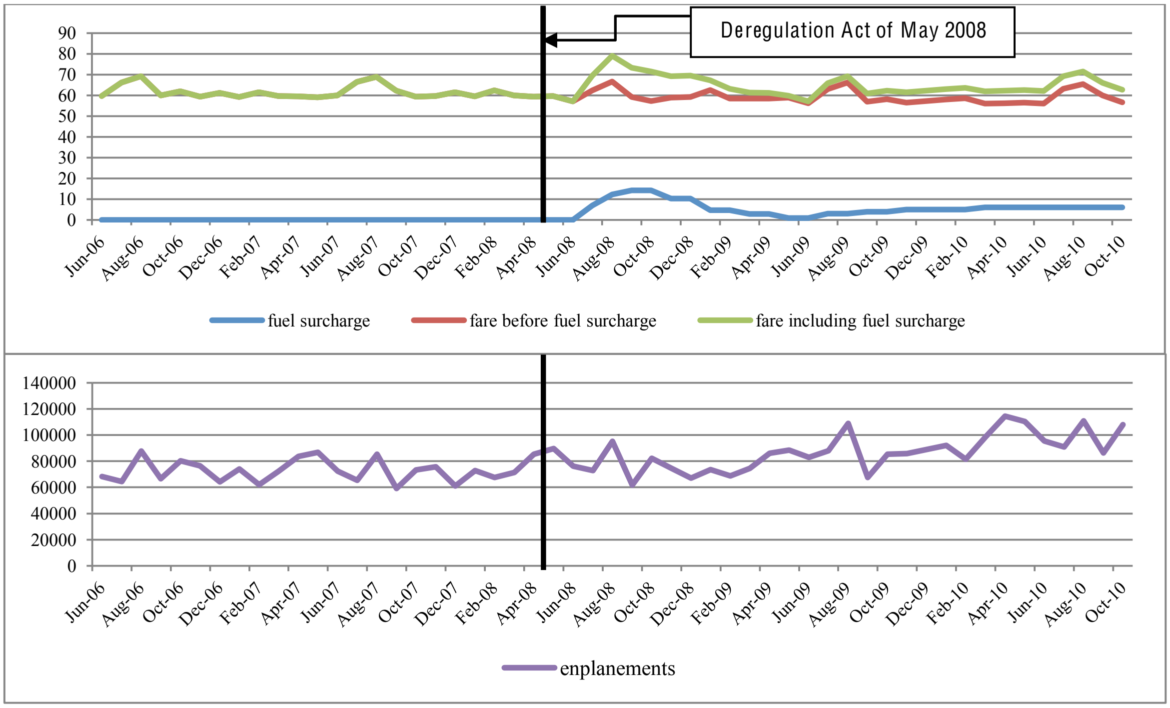


Figure 5: Average monthly fares (in US $) and enplanements: Jeju-Daegu route (r = 4)

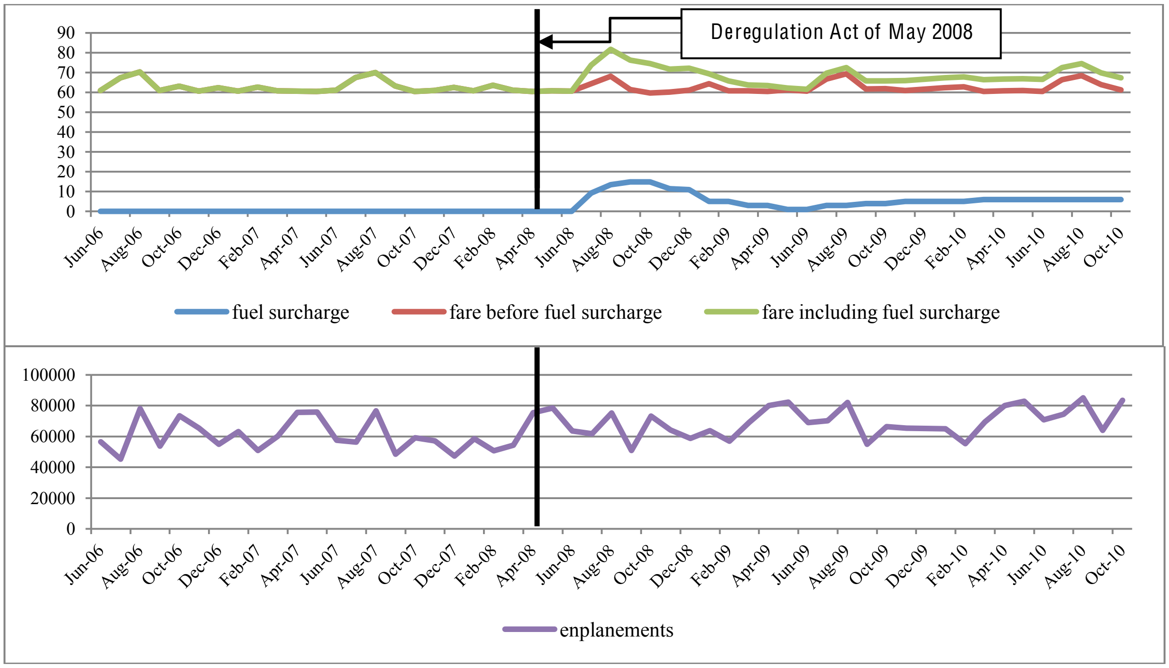


Figure 6: Average monthly fares (in US $) and enplanements: Jeju-Gwangju route (r = 5)

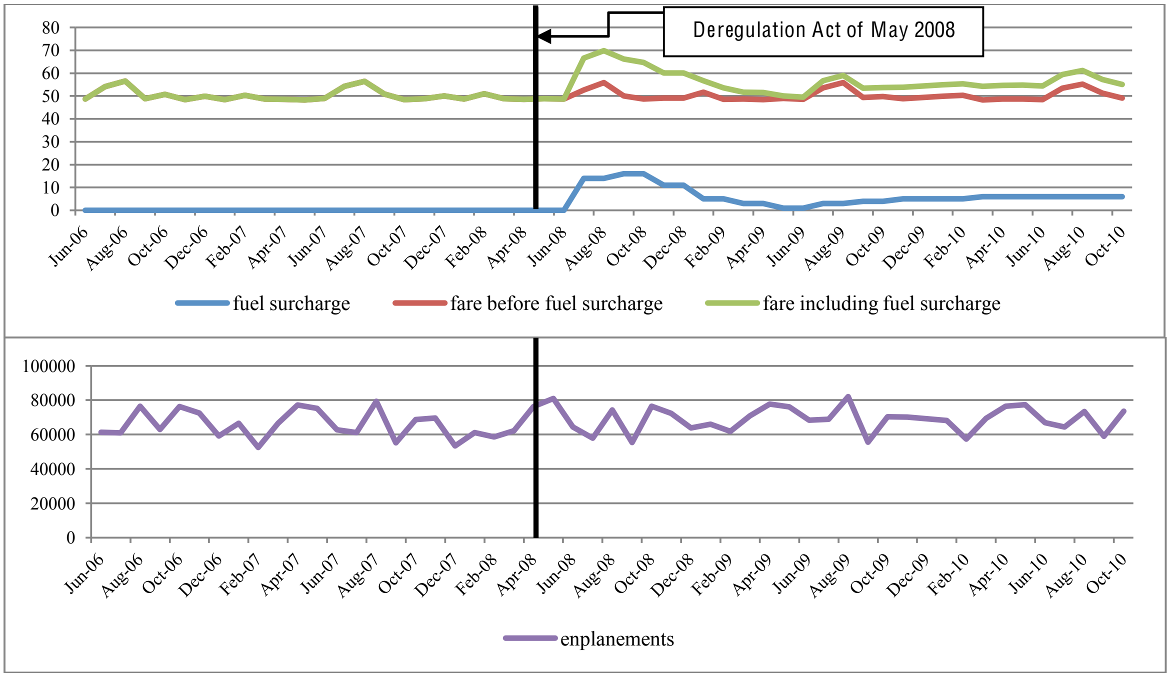
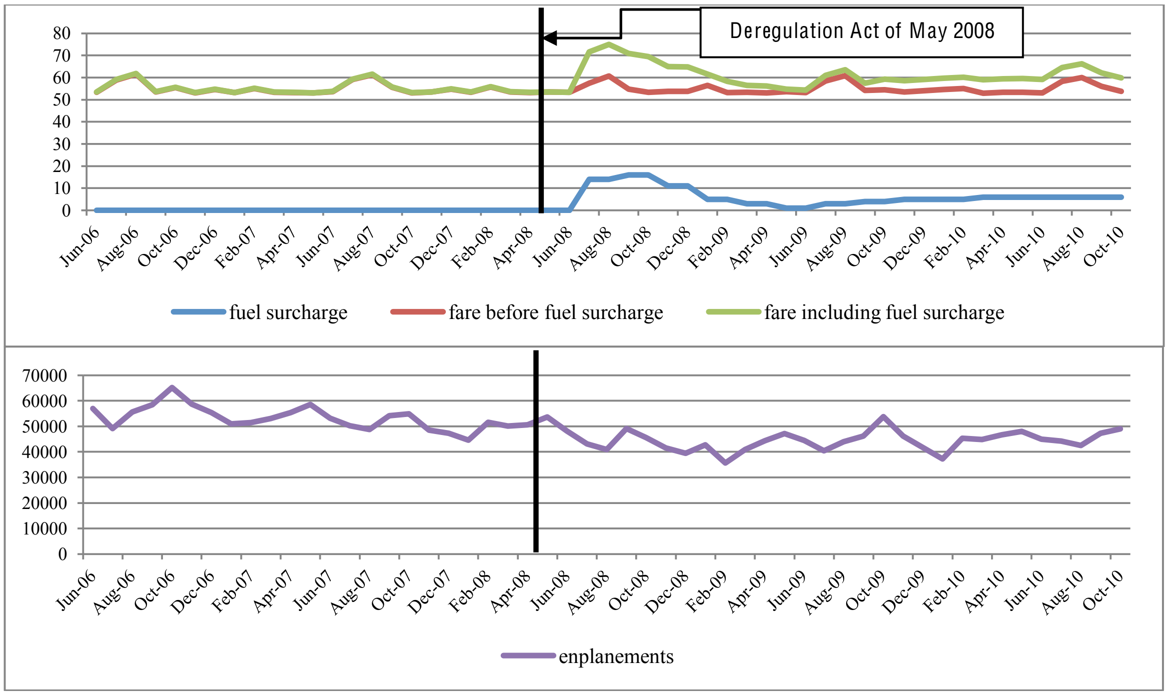


Figure 7: Average monthly fares (in US $) and enplanements: Seoul-Gwangju route (r = 7)



Testing for weak instruments[17]

The linear IV regression model with multiple endogenous regressor $(n > 1)$ is

$$y = Y\beta + X\gamma + u \tag{1}$$

and

$$Y = Z\Pi + X\Phi + v \tag{2}$$

where Y are $T \times n$ vectors of observations on endogenous variables, X is a $T \times K_1$ matrix of included exogenous variables, Z is a $T \times K_2$ matrix of instruments, and u and v are $T \times n$ vectors of disturbance terms. It is assumed throughout that $K_2 \geq n$. The errors $[u_t\, v_t]'$ are assumed to be *iid* $N(0, \sum)$, where the elements of $\sum$ are σ_u^2, σ_{uv}, and σ_v^2.

In Stock and Yogo (2002), the *concentration parameter,* a $K_2 \times K_2$ matrix, μ^2 is defined to measure the strength of the instruments, $\mu^2 = \sum_{VV}^{1/2'} \Pi' Z' Z \Pi \sum_{VV}^{1/2}$, where $\sum_{VV}$ is a covariance matrix of the vector of errors v. μ^2 is relevant to the F statistic in eq(2), the first stage F statistic. Let $\widetilde{F}$ be the computed value of F using the true σ_v^2, such as $K_2\widetilde{F} \sim Chi^2(df = K_2)$ and $E(\widetilde{F}) = \mu^2/K_2 + 1$. If the sample size is large, then F and $\widetilde{F}$ are close, so $E(F) \cong \mu^2/K_2 + 1$, the first-stage F statistic. In order to have a set of instruments strong enough, the matrix μ^2/K_2 must be sufficiently large in the sense that its smallest eigenvalue is large. Inference about μ^2 can be based on the $n \times n$ matrix analog of the first-stage F statistic, $G_T = \hat{\sum}_{VV}^{-1/2'} Y' P_Z Y \hat{\sum}_{VV}^{-1/2} / K_2$, where $\hat{\sum}_{VV} = Y' M_Z Y / (T - K_2)$, $M_Z = I - P_Z$, and I is a conformable identity matrix. Under weak-instruments asymptotic, $E(G_T) \rightarrow \mu^2/K_2 + I$. Cragg-Donald (1993) proposed using G_T to test for identification. Accordingly, Stock and Yogo provided tables of critical values in Table 5-2, based on the minimum eigenvalue of G_T.

[17] Source: Stock & Yogo (2005)

In Stock and Yogo (2005), the definition of *size of test* refers to the researcher's tolerance for departures from the usual standards of inference. The standard normal 5% hypothesis test is thrown off by the weak first stage estimates when the instruments are relevant but weak, $\Pi \neq 0$ in eq(2). The tails are flatter than one would expect if one took a parameter in the second stage and tested it as if one would test a parameter in an OLS. Then, one may think (say) 15% is good enough to reject the null and this may correspond with an OLS calculation of 5% given some number of first stage regressors. The *size of test* refers to the maximum of the willingness rejection rate, $r(\%)$.

Figure 8: Critical values for the weak instrument test based on Two Stage Least Square (TSLS) size (The OLS equivalent significance level is 5%)

Table 5.2. *Critical values for the weak instrument test based on TSLS size* (Significance level is 5%)

	$n = 1, r =$				$n = 2, r =$			
K_2	0.10	0.15	0.20	0.25	0.10	0.15	0.20	0.25
1	16.38	8.96	6.66	5.53				
2	19.93	11.59	8.75	7.25	7.03	4.58	3.95	3.63
3	22.30	12.83	9.54	7.80	13.43	8.18	6.40	5.45
4	24.58	13.96	10.26	8.31	16.87	9.93	7.54	6.28
5	26.87	15.09	10.98	8.84	19.45	11.22	8.38	6.89
6	29.18	16.23	11.72	9.38	21.68	12.33	9.10	7.42
7	31.50	17.38	12.48	9.93	23.72	13.34	9.77	7.91
8	33.84	18.54	13.24	10.50	25.64	14.31	10.41	8.39
9	36.19	19.71	14.01	11.07	27.51	15.24	11.03	8.85
10	38.54	20.88	14.78	11.65	29.32	16.16	11.65	9.31
11	40.90	22.06	15.56	12.23	31.11	17.06	12.25	9.77
12	43.27	23.24	16.35	12.82	32.88	17.95	12.86	10.22
13	45.64	24.42	17.14	13.41	34.62	18.84	13.45	10.68
14	48.01	25.61	17.93	14.00	36.36	19.72	14.05	11.13
15	50.39	26.80	18.72	14.60	38.08	20.60	14.65	11.58
16	52.77	27.99	19.51	15.19	39.80	21.48	15.24	12.03
17	55.15	29.19	20.31	15.79	41.51	22.35	15.83	12.49
18	57.53	30.38	21.10	16.39	43.22	23.22	16.42	12.94
19	59.92	31.58	21.90	16.99	44.92	24.09	17.02	13.39
20	62.30	32.77	22.70	17.60	46.62	24.96	17.61	13.84
21	64.69	33.97	23.50	18.20	48.31	25.82	18.20	14.29
22	67.07	35.17	24.30	18.80	50.01	26.69	18.79	14.74
23	69.46	36.37	25.10	19.41	51.70	27.56	19.38	15.19
24	71.85	37.57	25.90	20.01	53.39	28.42	19.97	15.64
25	74.24	38.77	26.71	20.61	55.07	29.29	20.56	16.10
26	76.62	39.97	27.51	21.22	56.76	30.15	21.15	16.55
27	79.01	41.17	28.31	21.83	58.45	31.02	21.74	17.00
28	81.40	42.37	29.12	22.43	60.13	31.88	22.33	17.45
29	83.79	43.57	29.92	23.04	61.82	32.74	22.92	17.90
30	86.17	44.78	30.72	23.65	63.51	33.61	23.51	18.35

1. Jeju-Seoul route: If instruments are weak, the actual rejection rate of the null hypothesis, known as the test size, may be larger than the 5% level of statistical significance, $\alpha = 0.05$. According to Stock and Yogo (2005), the test statistic is based on the rejection rate tolerable to the researcher if the true rejection rate is 5%. Their tabulated values report various rejection rates. Thus, one can test the null hypothesis, H_0 : The instruments are weak, against the alternative. According to the Cragg-Donald F-test for the multiple endogenous variables, fare p^r_{jt} and within group share $ln\left(s_{jt/gt}\right)$, there is no significant evidence to reject each of three null hypotheses, H_0 : The BLP type instruments are weak, H_0 : The Hausman type instruments are weak, and H_0 : A mix of both BLP type and Hausman type instruments is weak. One possible explanation for this failure is due to a poor fit of the first stage regression for the within group share variable, $ln\left(s_{jt/gt}\right)$. The Cragg-Donald F-test, however, for multiple endogenous variables does not specify the source of failure to reject the null hypothesis. There may be a few strong instruments and many weak ones, resulting in a combined set of instruments that is weak. Weak instruments may be generating undesirable biases in point estimation results.

2. Jeju-Busan route: The Cragg-Donald Wald F statistics for the multiple endogenous variables, fare p^r_{jt} and within group share $ln\left(s_{jt/gt}\right)$, indicate that one can reject the null hypothesis, H_0 : The combined instruments of the BLP and the Hausman type are weak, if one is willing to accept a maximum rejection rate of 20% for a test at the 5% level of significance. There is no significant evidence to reject each of two null hypotheses, H_0 : The BLP type instruments are weak, and H_0 : The Hausman type instruments are weak. The Cragg-Donald F-test, however, for multiple endogenous variables does not specify the source of failure to reject the null hypothesis.

3. Jeju-Cheongju route: The Cragg-Donald Wald F statistics for the multiple endogenous variables, fare p^r_{jt} and within group share $ln\left(s_{jt/gt}\right)$, indicate that one can reject each

of three null hypotheses, H_0 : The BLP type instruments are weak if one is willing to accept a maximum rejection rate of 25% for a test at the 5% level of significance, H_0 : The Hausman type instruments are weak if one is willing to accept a maximum rejection rate of 10% for a test at the 5% level of significance, and H_0 : A mix of BLP type and Hausman type instruments is weak if one is willing to accept a maximum rejection rate of 15% for a test at the 5% level of significance.

4. Jeju-Daegu route: The Cragg-Donald Wald F statistics for the multiple endogenous variables, fare p^r_{jt} and within group share $ln\left(s_{jt/gt}\right)$, indicate that there is no significant evidence to reject each of three null hypotheses, H_0 : The BLP type instruments are weak, H_0 : The Hausman type instruments are weak, and H_0 : A mix of both BLP type and Hausman type instruments is weak. One possible explanation for this failure is due to a poor fit of the first stage regression for the within group share variable, $ln\left(s_{jt/gt}\right)$. The Cragg-Donald F-test, however, for multiple endogenous variables does not specify the source of failure to reject the null hypothesis. There may be a few strong instruments and many weak ones, resulting in a combined set of instruments that is weak. Weak instruments may be generating undesirable biases in point estimation results.

5. Jeju-Gwangju route: The Cragg-Donald F-test for the two endogenous variables, p^r_{jt} and $ln\left(sjt/gt\right)$, can reject each of three null hypotheses, H_0 : The BLP instruments are weak if one is willing to accept a maximum rejection rate of 20% for a test at the 5% level of significance, H_0 : The Hausman type instruments are weak if one is willing to accept a maximum rejection rate of 15% for a test at the 5% level of significance, and H_0 : A mix of BLP type and Hausman type instruments is weak if one is willing to accept a maximum rejection rate of 10% for a test at the 5% level of significance.

6. Seoul-Busan route: According to the Cragg-Donald F-test for the multiple endogenous variables, fare p^r_{jt} and within group share $ln\left(s_{jt/gt}\right)$, each of the null hypotheses (H_0 :

The BLP instruments are weak, H_0 :The Hausman instruments are weak, and H_0: The combined instruments of the BLP and the Hausman are weak) is tested. There is no significant evidence to reject any of the three null hypotheses. One possible explanation for this failure is due to a poor fit of the first stage regression for the within group share variable, $ln\left(s_{jt/gt}\right)$. The Cragg-Donald F-test, however, for multiple endogenous variables does not specify the source of failure to reject the null hypothesis. There may be a few strong instruments and many weak ones, resulting in a combined set of instruments that is weak. Weak instruments may be generating undesirable biases in point estimation results.

7. Seoul-Gwangju route: The Cragg-Donald F-tests for two endogenous variables, p^r_{jt} and $ln\left(s^{jt}/_{gt}\right)$, indicate that one can reject each of two null hypotheses, H_0 : The Hausman type instruments are weak if one is willing to accept a maximum rejection rate of 25% for a test at the 5% level of significance, and H_0 : A mix of BLP type and Hausman type instruments is weak if one is willing to accept a maximum rejection rate of 10% for a test at the 5% level of significance. There is no statistical evidence to reject the null hypothesis H_0 : The BLP type instruments are weak. The Cragg-Donald F-test, however, for multiple endogenous variables does not specify the source of failure to reject the null hypothesis.

In total, for at least one column in the demand estimation results tables for five of the routes one can reject the null hypothesis for at least one of the instrument sets. This along with the stability of the Fare coefficient across instruments sets within the route tables and the consistency of the Fare results across route/tables, leads to a conclusion that weak instruments are not driving results. Note that for most variables the coefficients are robust as well within tables for a single route and across tables for the five Jeju routes. Since the coefficient on the Fare variable is our primary focus we proceed using these estimates.

Joint constraint for the nesting parameter, σ_r

A. Jeju island routes, $\forall r = 1,2,3,4,5$

The Wald tests for the joint equality for the nesting parameter σ_r across the Jeju island routes, $H_0 : \sigma_1 = \sigma_2 = \sigma_3 = \sigma_4 = \sigma_5$, are tested.

1.Nesting parameter σ_r

$Chi^2(4) = 289.10$

$Prob > Chi^2 = 0.000$

B. Inland routes, $\forall r = 6,7$

The Wald tests for the joint equality for the nesting parameter σ_r across the inland routes, $H_0 : \sigma_6 = \sigma_7$, are tested.

1.Nesting parameter σ_r

$Chi^2(1) = 15.73$

$Prob > Chi^2 = 0.000$

Average own- and cross- price elasticities

Table 13: Average own- and cross-price elasticities: Jeju-Seoul route (r = 1)

Average own- and cross-price elasticities: Time period: June 2006 - June 2008

Jeju-Seoul	KAL	AAR	JNA	ONA	HAN	JJA	ESR	TWB
KAL	-2.051	2.880	N/A	N/A	2.880	2.880	N/A	N/A
AAR	1.505	-3.426	N/A	N/A	1.505	1.505	N/A	N/A
JNA	N/A							
ONA	N/A							
HAN	0.115	0.115	N/A	N/A	-3.812	0.115	N/A	N/A
JJA	0.284	0.284	N/A	N/A	0.284	-3.262	N/A	N/A
ESR	N/A							
TWB	N/A							

Average own- and cross-price elasticities: Jin Air (JNA) presence: July 2008 - October 2010

Jeju-Seoul	KAL	AAR	JNA	ONA	HAN	JJA	ESR	TWB
KAL	-3.045	1.974	1.974	1.974	1.974	1.974	1.974	1.974
AAR	1.303	-3.709	1.303	1.303	1.303	1.303	1.303	1.303
JNA	0.454	0.454	-3.566	0.454	0.454	0.454	0.454	0.454
ONA	0.020	0.020	0.020	-5.172	0.020	0.020	0.020	0.020
HAN	0.196	0.196	0.196	0.196	-4.159	0.196	0.196	0.196
JJA	0.491	0.491	0.491	0.491	0.491	-3.591	0.491	0.491
ESR	0.520	0.520	0.520	0.520	0.520	0.520	-3.408	0.520
TWB	0.148	0.148	0.148	0.148	0.148	0.148	0.148	-4.004

Cell entries (i,j), where i indexes row and j column, give the percentage change in market share of j with a change in the price of i. The values in each diagonal cells represent the own-price elasticities while the values in off-diagonal cells represent the cross-price elasticities of demand for flight j with respect to flight i price.

Table 14: Average own- and cross-price elasticities: Jeju-Busan route (r = 2)

Average own- and cross-price elasticities: Time period: June 2006 - June 2008

Jeju-Busan	KAL	AAR	ABL	JNA	ONA	JJA
KAL	-1.363	2.930	N/A	N/A	N/A	2.930
AAR	1.019	-3.243	N/A	N/A	N/A	1.019
ABL			N/A			
JNA			N/A			
ONA			N/A			
JJA	0.266	0.266	N/A	N/A	N/A	-2.905

Average own- and cross-price elasticities: July 2008 - March 2009

Jeju-Busan	KAL	AAR	ABL	JNA	ONA	JJA
KAL	-2.004	N/A	2.817	N/A	2.817	2.817
AAR	Asiana Air rebadged to Air Busan (ABL) in Dec 2008.					
ABL	1.228	N/A	-3.437	N/A	1.228	1.228
JNA			N/A			
ONA	0.081	N/A	0.081	N/A	-4.696	0.081
JJA	0.538	N/A	0.538	N/A	0.538	-3.274

Average own- and cross-price elasticities: April 2009 - November 2009, Jin Air (JNA) presence

Jeju-Busan	KAL	AAR	ABL	JNA	ONA	JJA
KAL	-2.566	N/A	1.653	1.653	N/A	1.653
AAR	Asiana Air rebadged to Air Busan (ABL).					
ABL	1.239	N/A	-2.653	1.239	N/A	1.239
JNA	0.538	N/A	0.538	-2.741	N/A	0.538
ONA			N/A			
JJA	0.430	N/A	0.430	0.430	N/A	-3.022

Average own- and cross- price elasticities: January 2010 - October 2010

Jeju-Busan	KAL	AAR	ABL	JNA	ONA	JJA
KAL	-2.410	N/A	1.877	N/A	N/A	1.877
AAR	Asiana Air rebadged to Air Busan (ABL).					
ABL	1.597	N/A	-2.391	N/A	N/A	1.597
JNA			N/A			
ONA			N/A			
JJA	0.572	N/A	0.572	N/A	N/A	-2.997

Cell entries (i, j), where i indexes row and j column, give the percentage change in market share of j with a change in the price of i . The values in each diagonal cells represent the own-price elasticities while the values in off-diagonal cells represent the cross-price elasticities of demand for flight j with respect to flight i price.

Table 15: Average own- and cross-price elasticities: Seoul-Busan route (r = 6)

Average own- and cross-price elasticities: Time period: June 2006 - September 2008

Seoul-Busan	KAL	AAR	ABL	JNA	JJA
KAL	-0.823	3.331	N/A	N/A	3.331
AAR	0.798	-3.326	N/A	N/A	0.798
ABL			N/A		
JNA			N/A		
JJA+	0.036	0.036	N/A	N/A	-3.210

+JJA ceased the Seoul-Busan route service in Feb 2007.

Average own- and cross-price elasticities: October 2008 - Decemeber 2008

Seoul-Busan	KAL	AAR	ABL	JNA	JJA
KAL	-0.845	N/A	3.681	N/A	N/A
AAR	AAR rebadged to Air Busan (ABL) in Oct 2008.				
ABL	0.533	N/A	-3.383	N/A	N/A
JNA			N/A		
JJA			N/A		

Average own- and cross-price elasticities: January 2009 - March 2009, Jin Air (JNA) presence

Seoul-Busan	KAL	AAR	ABL	JNA	JJA
KAL	-1.000	N/A	3.038	3.038	N/A
AAR	AAR rebadged to Air Busan (ABL).				
ABL	0.765	N/A	-2.771	0.765	N/A
JNA	0.094	N/A	0.094	-3.083	N/A
JJA			N/A		

Average own- and cross- price elasticities: April 2009 - October 2010

Seoul-Busan	KAL	AAR	ABL	JNA	JJA
KAL	-1.661	N/A	2.360	N/A	N/A
AAR	AAR rebadged to Air Busan (ABL).				
ABL	1.445	N/A	-2.063	N/A	N/A
JNA			N/A		
JJA			N/A		

Cell entries (i, j), where i indexes row and j column, give the percentage change in market share of j with a change in the price of i . The values in each diagonal cells represent the own-price elasticities while the values in off-diagonal cells represent the cross-price elasticities of demand for flight j with respect to flight i price.

Calculation for the inter-firm departure flight times differentiation index, $BtwnDIFF$

1. $BtwnDIFF_{case(iii)} = 1.1420$

For case (iii) in Figure 5.2, $AVGDIFF_{case(iii)}$ is the average time distance between each pairs of six flights, $|d_{A1} - d_{A2}| = |6AM - 7AM|$, $|d_{A1} - d_{A3}| = |6AM - 12PM|$, $|d_{A1} - d_{B1}| = |6AM - 6PM|$, $|d_{A1} - d_{B2}| = |6AM - 7PM|$, $|d_{A1} - d_{B3}| = |6AM - 1PM|$, $|d_{A2} - d_{A3}| = |7AM - 12PM|$, $|d_{A2} - d_{B1}| = |7AM - 6PM|$, $|d_{A2} - d_{B2}| = |7AM - 7PM|$, $|d_{A2} - d_{B3}| = |7AM - 1PM|$, $|d_{A3} - d_{B1}| = |12PM - 6PM|$, $|d_{A3} - d_{B2}| = |12PM - 7PM|$, $|d_{A3} - d_{B3}| = |12PM - 1PM|$, $|d_{B1} - d_{B2}| = |6PM - 7PM|$, $|d_{B1} - d_{B3}| = |6PM - 1PM|$, $|d_{B2} - d_{B3}| = |7PM - 1PM|$.

The average time distance between all flights scheduled by different carriers is calculated by $|d_{A1} - d_{B1}| = |6AM - 6PM|$, $|d_{A1} - d_{B2}| = |6AM - 7PM|$, $|d_{A1} - d_{B3}| = |6AM - 1PM|$, $|d_{A2} - d_{B1}| = |7AM - 6PM|$, $|d_{A2} - d_{B2}| = |7AM - 7PM|$, $|d_{A2} - d_{B3}| = |7AM - 1PM|$, $|d_{A3} - d_{B1}| = |12PM - 6PM|$, $|d_{A3} - d_{B2}| = |12PM - 7PM|$, and $|d_{A3} - d_{B3}| = |12PM - 1PM|$.

When $\alpha = 0.5$,

$$BtwnDIFF_{case(iii)} = \frac{\frac{1}{9}\times(720^{0.5}+780^{0.5}+420^{0.5}+660^{0.5}+720^{0.5}+360^{0.5}+360^{0.5}+420^{0.5}+60^{0.5})}{\frac{1}{15}\times(60^{0.5}+360^{0.5}+720^{0.5}+780^{0.5}+420^{0.5}+300^{0.5}+660^{0.5}+720^{0.5}+360^{0.5}+360^{0.5}+420^{0.5}+60^{0.5}+60^{0.5}+300^{0.5}+360^{0.5})} = \frac{21.303}{18.654} = 1.1420$$

2. $BtwnDIFF_{case(iv)} = 1.146$

For case (iv) in Figure 5.2, $AVGDIFF_{case(iv)}$ is the average time distance between each pairs of six flights, $|d_{A1}-d_{A2}| = |6AM-7AM|$, $|d_{A1}-d_{B1}| = |6AM-6PM|$, $|d_{A1}-d_{B2}| = |6AM-7PM|$, $|d_{A1}-d_{C1}| = |6AM-12PM|$, $|d_{A1}-d_{C2}| = |6AM-1PM|$, $|d_{A2}-d_{B1}| = |7AM-6PM|$, $|d_{A2}-d_{B2}| = |7AM-7PM|$, $|d_{A2}-d_{C1}| = |7AM-12PM|$, $|d_{A2}-d_{C2}| = |7AM-1PM|$, $|d_{B1}-d_{B2}| = |6PM-7PM|$, $|d_{B1}-d_{C1}| = |6PM-12PM|$, $|d_{B1}-d_{C2}| = |6PM-1PM|$, $|d_{B2}-d_{C1}| = |7PM-12PM|$, $|d_{B2}-d_{C2}| = |7PM-1PM|$, $|d_{C1}-d_{C2}| = |12PM-1PM|$.

The average time distance between all flights scheduled by different carriers is calculated by $|d_{A1}-d_{B1}| = |6AM-6PM|$, $|d_{A1}-d_{B2}| = |6AM-7PM|$, $|d_{A1}-d_{C1}| = |6AM-12PM|$, $|d_{A1}-d_{C2}| = |6AM-1PM|$, $|d_{A2}-d_{B1}| = |7AM-6PM|$, $|d_{A2}-d_{B2}| = |7AM-7PM|$, $|d_{A2}-d_{C1}| = |7AM-12PM|$, $|d_{A2}-d_{C2}| = |7AM-1PM|$, $|d_{B1}-d_{C1}| = |6PM-12PM|$, $|d_{B1}-d_{C2}| = |6PM-1PM|$, $|d_{B2}-d_{C1}| = |7PM-12PM|$, and $|d_{B2}-d_{C2}| = |7PM-1PM|$.

When $\alpha = 0.5$,

$$BtwnDIFF_{case(iv)} = \frac{\frac{1}{12}\times(720^{0.5}+780^{0.5}+360^{0.5}+420^{0.5}+660^{0.5}+720^{0.5}+300^{0.5}+360^{0.5}+360^{0.5}+300^{0.5}+420^{0.5}+360^{0.5})}{\frac{1}{15}\times(60^{0.5}+720^{0.5}+780^{0.5}+360^{0.5}+420^{0.5}+660^{0.5}+720^{0.5}+300^{0.5}+360^{0.5}+60^{0.5}+360^{0.5}+300^{0.5}+420^{0.5}+360^{0.5}+60^{0.5})} = \frac{21.380}{18.654} = 1.146.$$

3. $BtwnDIFF_{case(v)} = 1.358$

For case (v) in Figure 5.3, $AVGDIFF_{case(v)}$ is the average time distance between each pairs of six flights, $|d_{A1}-d_{A2}| = |6AM-7AM|$, $|d_{A1}-d_{A3}| = |6AM-8AM|$, $|d_{A2}-d_{A3}| = |7AM-8AM|$, $|d_{A1}-d_{B1}| = |6AM-6PM|$, $|d_{A1}-d_{B2}| = |6AM-7PM|$, $|d_{A1}-d_{B3}| = |6AM-8PM|$, $|d_{A2}-d_{B1}| = |7AM-6PM|$, $|d_{A2}-d_{B2}| = |7AM-7PM|$, $|d_{A2}-d_{B3}| = |7AM-8PM|$, $|d_{A3}-d_{B1}| = |8AM-6PM|$, $|d_{A3}-d_{B2}| = |8AM-7PM|$, $|d_{A3}-d_{B3}| = |8AM-8PM|$, $|d_{B1}-d_{B2}| = |6PM-7PM|$, $|d_{B1}-d_{B3}| = |6PM-8PM|$, $|d_{B2}-d_{B3}| = |7PM-8PM|$.

The average time distance between all flights scheduled by different carriers is calculated by $|d_{A1}-d_{B1}| = |6AM-6PM|$, $|d_{A1}-d_{B2}| = |6AM-7PM|$, $|d_{A1}-d_{B3}| = |6AM-8PM|$, $|d_{A2}-d_{B1}| = |7AM-6PM|$, $|d_{A2}-d_{B2}| = |7AM-7PM|$, $|d_{A2}-d_{B3}| = |7AM-8PM|$, $|d_{A3}-d_{B1}| = |8AM-6PM|$, $|d_{A3}-d_{B2}| = |8AM-7PM|$, and $|d_{A3}-d_{B3}| = |8AM-8PM|$.

When $\alpha = 0.5$,

$$BtwnDIFF_{case(v)} = \frac{\frac{1}{9}\times(720^{0.5}+780^{0.5}+840^{0.5}+660^{0.5}+720^{0.5}+780^{0.5}+600^{0.5}+660^{0.5}+720^{0.5})}{\frac{1}{15}\times(60^{0.5}+120^{0.5}+60^{0.5}+720^{0.5}+780^{0.5}+840^{0.5}+660^{0.5}+720^{0.5}+780^{0.5}+600^{0.5}+660^{0.5}+720^{0.5}+60^{0.5}+120^{0.5}+60^{0.5})} = \frac{25.806}{19.009} = 1.358$$

Bibliography

Ackerberg and Rysman. Unobserved Product Differentiation in Discrete Choice Models: Estimating Price Elasticities and Welfare Effects. *The Rand Journal of Economics*, 36: 771–788, 2005.

Berry, Levinsohn, and Pakes. Automobile Prices in Market Equilibrium. *Econometrica*, 63 (4):841–890, 1995.

Steven Berry. Estimating Discrete-Choice Models of Product Differentiation. *The Rand Journal of Economics*, 24(2):242–262, 1994.

Borenstein and Netz. Why Do All the Flights Leave at 8 am? Competition and Departure-time Differentiation in Airline Markets. *International Journal of Industrial Organization*, 17:611–640, 1999.

Bresnahan, Stern, and Trajtenberg. Market Segmentation and the Source of Rents from Innovation: Personal Computers in the Late 1980s. *The Rand Journal of Economics*, 28 (0):S17–S44, 1997.

Card and Krueger. Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania: Reply. *The American Economic Review*, 90(5): 1397–1420, 2000.

Gregory Crawford. The Impact of the 1992 Cable Act on Household Demand and Welfare. *The Rand Journal of Economics*, 31(3), 2000.

Rigas Doganis. *Flying Off Courses:Airline Economics and Marketing*. Routledge, 2006.

García-Gallego and Georgantzís. Multiproduct Activity in an Experimental Differentiated Oligopoly. *International Jouornal of Industrial Organization*, 19:493–518, 2001.

Marina Di Giacomo. GMM Estimation of a Structural Demand Model for Yogurt and the Effects of the Introduction of New Brands. *Empirical Economics*, 34:537–565, 2008.

Hausman, Leonard, and Zona. Competitive Analysis with Differentiated Products. *Annales d́Economie et de Statistique*, 34:159–180, 1994.

Ivaldi and Verboven. Quantifying the Effects from Horizontal Mergers in European Competition Policy. *International Journal of Industrial Organization*, 23:669–691, 2005.

Morrison and Winston. *The Economic Effects of Airline Deregulation*. Brookings Institution, 1986.

Netz and Taylor. Maximum or Minimum Differentiation? Location Patterns of Retail Outlets. *The Review of Economics and Statistics*, 84(1):162–175, 2002.

Aviv Nevo. A Practitioner's Guide to Estimation of Random Coefficients Logit Models of Demand. *Journal of Economics and Management Strategy*, 9(4):513–518, 2000.

Aviv Nevo. Measuring Market Power in the Ready-To-Eat Cereal Industry. *Econometrica*, 69(2):307–342, 2001.

Amil Petrin. Quantifying the Benefits of New Products: The Case of the Minivan. *Journal of Political Economy*, 110(4), 2002.

Stock and Yogo. *Identification and Inference for Econometric Models*. Cambridge University Press, 2005.

Stock, Wright, and Yogo. A Survey of Weak Instruments and Weak Identification in Generalized Methods of Moments. *Journal of Business and Economic Statistics*, 20(4), 2002.

Manuel Trajtenberg. The Welfare Analysis of Product Innovations, with an Application to Computed Tomography Scanners. *Journal of Political Economy*, 97(2), 1989.

Frank Verboven. International Price Discrimination in the European Car Market. *The Rand Journal of Economics*, 27(2):240–268, 1996.

Yetiskul and Kanafani. How the Presency of Low Cost Carrier Competition Scheduling Differentiation. *Journal of Air Transport Management*, 16:7–11, 2010.