Modeling Bilateral Air Services Agreement for the Purpose of Measuring the Economic Effects of Air Transport Liberalization: A Case Study of Canada and China

by

Wei Song

Master of Arts in Economics, University of New Brunswick, 2005

A THESIS SUBMITTED IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN BUSINESS ADMINISTRATION

in

THE FACULTY OF GRADUATE STUDIES

THE UNIVERSITY OF BRITISH COLUMBIA
(Vancouver)

August 2009

© Wei Song, 2009

Abstract

International air services are mostly regulated by bilateral Air Services Agreements (ASAs) signed by each pair of countries. Most of the bilateral ASAs are still operated within the framework of the Chicago Convention, and considered to be restrictive and inefficient to serve international air markets. Over the last two decades, the United States, European Union, and some other countries have pioneered liberalization of bilateral ASAs and received remarkable positive results. Although Canadian government released a "Blue Sky" policy in 2006 to pursue negotiation of Open Skies-type agreements, many of the major air markets, such as the Canada–China market, are still regulated by restricted ASAs. Whether or not to liberalize bilateral ASAs and what are the impacts of liberalization has become an interest to airlines, investors, consumers and regulators. However, the existing studies are insufficient for understanding the magnitudes of potential impacts of such liberalization, and, hence, to provide direct insights to policy makers. Therefore, there is a need for a new study for simulating potential economic effects of ASA liberalization.

The primary objective of this thesis is to develop a computable model to estimate potential economic effects of bilateral ASA liberalization between Canada and China. In particular, this study aims to estimate how the market shares of the flag carriers would change and how the gains and losses would be changed among passengers and carriers in either country. To address these objectives, we compare the simulation results between the base case (2006 data without liberalization) and the case of liberalizing Canada-China ASA to a varying degree in order to estimate the impacts of the liberalization.

The major findings are: (a) airfare would decrease with air liberalization, which would stimulate more passengers, and induce airlines to increase flight frequency. ; (b) in most of the cases, passengers carried by incumbent carriers would increase even if new airlines enter the routes; (c) although carriers' profit would decrease, the aggregate economic welfare would increase because consumer benefits would increase dramatically; and (d) while any level of air liberalization would be positive, Open Skies would have the greatest impacts on both countries.

Table of Contents

List of Tables

List of Figures

Acknowledgments

I would like to offer my enduring gratitude to my supervisor, Professor Tae H. Oum, who inspired me to continue my study in this field throughout my years at UBC and kindly offered his helps to complete my thesis. I would also like to thank Professor David Gillen and Professor Anming Zhang for serving on my committee with their supports and valuable comments. I owe particular thanks to Dr. Chunyan Yu for her kind helps and providing useful suggestions.

I would like to thank my parents for supporting me throughout the years I have been through, both morally and financially.

Special thanks are owed to my husband, Michael He, who has provided endless supports during the whole program and gave me the power to overcome all the obstacles.

Chapter 1. Introduction

The significance of air transport has been recognized worldwide. It forges links between countries and cultures, provides access to global markets, and facilitates economic and social progress. Air Transport Action Group (ATAG, 2008) estimates that over 40% of international tourists travel by air, that 32 million jobs (direct and indirect) are generated by air transport industry worldwide, and that aviation accounts for 7.5% of the worldwide Gross Domestic Product (GDP). Nevertheless, commercial air services have yet to be incorporated into the General Agreement on Trade in Services (GATS) governed by the World Trade Organization (WTO). International air services are still operated within the framework of the 1944 Chicago Convention[1] on international air transportation, which had been considered to be restrictive and inefficient to serve international air services. Whether or not international Air Services Agreements (ASAs) should be liberalized became a deliberation not only among policy makers but also among researchers.

1.1. Background

International air services are generally regulated by bilateral Air Services Agreements (ASAs), which are signed by two countries to govern civil aviation between them. Currently, there are about 5,500 bilateral ASAs[2] in the world regulating the increasingly complex international airline systems. In general, bilateral ASAs can be classified into two categories: producer-interest agreements and consumer-interest agreements.

Producer-interest agreements typically include:

- the pre-determination of capacity, in which governments must approve schedules in advance;
- the designation of points that can be served rather than general grants of traffic freedom;

[1] The Chicago Convention, or the Convention on International Civil Aviation, was signed on December 7th, 1944 by 52 States. Along with the 26th ratification received on March 5th, 1947, it went into effect on April 4th, 1947.

[2] Compiled from ICAO Database of Aeronautical Agreements and Arrangement

- the provisions of price and capacity coordination among national flag carriers, which may be limited to one of each party (single designation), and complex controls on airline pricing (such procedures are rarely enforced today).

Producer-interest agreements, which in some cases expressly sanction cartel-type practices such as price-fixing and mandatory pooling of revenues, basically see competition as inefficient and wasteful if not harmful. This type of agreement benefits the consumer through stability of supply and quality of service of established carriers.

Consumer-interest agreements, on the other hand, seek to remove entry controls, and establish discipline by the market. Many studies show that this type of agreement will lead to greater consumer choice as well as higher producer efficiency (Gillen, Harris and Oum, 2002; Morrison and Winston, 1986; Schipper, Rietveld, and Nijkamp, 2002; etc.).

Traditional bilateral ASAs are generally producer-interest agreements and they are operated under the Chicago Convention that "no schedule international air service may be operated over or into the territory of a contracting State, except with the special permission or other authorization of that State, and in accordance with the terms of such permission or authorization" (Chicago Convention 1944, Article 6). The Bermuda Agreement signed between U.S. and U. K. in 1946 has served as a legal bilateral ASAs framework so that most of the agreements followed its form, even for those recently signed (Gillen, Harris, and Oum, 2002).

This type of agreements contains detailed clauses on carrier and route designation, capacity allocation, price, etc. and thus too restrictive and inefficient to meet the rapidly increasing demands for international air services. Over the last three decades, the worldwide trend has been to move away from producer-interest agreements towards liberalized air services agreements in which restrictions on price, seat capacity and entry are removed or relaxed. For example, consumer-interest bilateral ASAs such as Open Skies ASAs, initialled by the United States in 1992, are the major regulatory movements towards air services liberalization.

As of March 2009, 157 bilateral Open Skies agreements had been reportedly concluded worldwide.

The movement towards air services liberalization also extends to the form of multilaterals, such as the Multilateral Air Services Agreement (MASA) of the Caribbean Community. Since the late 1990s, both the ICAO and the WTO have attempted to devise a multilateral framework for trade in air services similar to General Agreement on Tariffs (GATT) and General Agreement on Trade in Services (GATS). Unfortunately, there is no indication that these efforts will succeed in the foreseeable future. On the other hand, the increasing trend towards liberalizing air services both on bilateral and as well as regional basis is continuing. It is estimated that, in 2007, about 30 percent of country-pairs with non-stop scheduled passenger air services and over half of the frequencies offered were covered by either bilateral "open skies" air services agreements or regional/plurilateral liberalized agreements and arrangements (as compared to about 6 percent and 33 percent, respectively, a decade ago). Therefore, it is expected that there will continue to be a global dependence primarily on the bilateral air services agreements for airline market and route development in the foreseeable future.

After the 1978 domestic deregulation, the United States has continued to push for the liberalization of the international aviation market. Since its first Open Skies agreement with the Netherlands in 1992, the U.S. has signed Open Skies Agreements with over 92 countries in six continents. Beneficial from the sheer size of its deregulated domestic market and its leading position in the liberalization of the international air services, the U.S. has become the open skies hub nation, which consequently would help retain and increase the competitiveness of U.S. airlines and facilitate the development of airports and other industries.

Encouraged by the significantly positive effects of the U.S. initiated bilateral air liberalization, many other countries see the US Open Skies agreement as a successful model and have been galvanized to establish liberalized ASAs systems of their own. The following are some of the examples:

- The United Kingdom and Germany were forced to expand their air services with the U.S. when the latter signed Open Skies Agreements with the Netherlands and Belgium.
- The U.S. and Canada signed an "Open Skies" Agreement in 1995 authorizing any U.S. and Canadian airline to offer, for the first time, transborder services involving the 3rd and 4th freedom traffic without restriction. A more expanded Open Skies Agreement was signed between these two countries in 2007 which includes fifth freedom rights and 7th freedom rights for cargo, etc.
- The Open Aviation Area Agreement, a breakthrough in global air service, was signed between the European Union and the United States. This agreement came into effect on March 30th, 2008.
- The E.U., on behalf of its 27 member countries, has launched negotiations to liberalize its bilateral ASAs with a large number of countries including Canada[3].

Although air liberalization was initiated by the U.S. and has been extended all over the world, Canada still follows a rather restrictive approach to bilateral ASAs: out of its 79 bilateral ASAs with other countries, only six of them are Open Skies-type agreements.

In November 2006, the Canadian government released its "Blue Skies" policy to "pursue the negotiation of Open Skies-type agreements when it is in Canada's overall interest" (Transport Canada, 2006). The government has since signed Open Skies Agreements with the U.S., Ireland, Iceland, Barbados, and E.U[4]. Nevertheless, the Canadian government has not been proactively pursuing any Open Skies ASA with Asian countries, in spite of the fact that the Province of British Columbia and Canada as a whole are developing trade and investment relationships with these countries very rapidly. For instance, although China is one of Canada's top 10 trade partners, the current air markets between Canada and China are still heavily regulated by the rather restrictive bilateral ASA concluded on September 9, 2005.

---

[3] Canada – E.U. Open Skies Agreement was concluded on December 9, 2008. This agreement includes unrestricted direct air services between Canada and EU Member States; flexible pricing arrangements; and improved flexibility for cargo.

[4] An Open Skies Agreement was concluded between Canada and South Korea on July 15, 2009

One of challenging task for the policy makers is to examine the potential effects of air service liberalization between Canada and its significant trade partners such as China. What would happen to both countries if they were to agree to a more liberalized bilateral ASA or even an Open Skies agreement? Will the Canada – China Open Skies be in Canada's interest? Unfortunately, the existing literature is not adequate to answer these and related questions clearly. This thesis attempts to contribute to Canada's and China's policy deliberation on this issue by measuring quantitatively where possible the expected effects of liberalizing Canada-China ASA on both countries' economy, airlines, and travelers.

1.2. Purpose and Significance

The objectives of this research are to:

- measure the expected impacts of liberalizing the Canada-China air services agreement on the economic welfare of either country,
- predict how market shares of the two countries' flag carriers would change,
- estimate how the gains and losses would be changed among passengers and carriers in either country,
- explore implications of the findings on Canada's strategy on the bilateral ASA vis-à-vis China.

There have been many studies investigating the effects of liberalizing air services policies and regulations. Using historical data, these studies estimated econometrically the effects of air liberalization on some specific routes, which could help policy makers learn from the experiences, thus enabling them to make proper decisions in similar situations. However, every country is unique in terms of economic, business, and political environments, there is a need to conduct an empirical analysis for each important issue requiring policy decision. For example, the key issues concerning Canada-China bilateral ASA may be substantially different from those of UK, Germany, and even Japan or Korea. This means that specific studies should be conducted for each bilateral ASA. Therefore, it is necessary to develop a model to simulate how air transport systems and markets change as a result of an air policy change or a change in a bilateral ASA. The model would allow us to examine the outcomes for the airlines and passengers under different bilateral liberalization scenarios and estimate consociated gains and/or losses.

1.3. Scope

The primary objective of this research is to measure expected effects of the bilateral air services liberalization on the Canada – China market by adopting a partial equilibrium analysis (given the fact that comparable and consistent data for a general equilibrium model is difficult to obtain). The secondary objective is to analyze the change in the gains and/or losses produced by the policy changes among passengers and carriers in each country.

This thesis attempts to construct a computable model to predict the effects of air liberalization and applies it to the Canada – China air transport market. Ideally, the model should capture the effects of liberalizing a bilateral ASA on:

- the origin-destination traffic between the two countries, say, country A and country B,
- the transit traffic coming from behind country A (or B), say from country C to go to country B (or A) or to a point beyond country B via country A (or B),
- the through traffic traveling between countries C and D with connections at country A and country B.

However, because of the time and resource limitations and the limited data availability, we are forced to limit our analysis only to the total traffic volume between two pairs of airports between Canada and China. In other words, our analysis is of a partial equilibrium in nature. In addition, due to the limited data availability, it is impossible to map a whole air network system with all possible routes. As a result, only a small set of alternative routes that closely related to the Canada – China market will be included in our simulation model. Specifically the study is limited to the analysis of direct Canada – China air routes and following one-stop routes:

- Toronto – Tokyo/Seoul/Hong Kong – Beijing
- Toronto – Tokyo/Seoul/Hong Kong – Shanghai
- Vancouver – Tokyo/Seoul/Hong Kong – Beijing
- Vancouver – Tokyo/Seoul/Hong Kong – Shanghai

The spillover effects on other markets are outside the scope of this thesis.

1.4. Outline and Organization

The rest of the thesis is organized as follows: Chapter 2 describes the current status of the air transport network in the Asia Pacific Region. Literature review of the economic effects of bilateral air liberalization is presented in Chapter 3. Since the parameters in the model are "borrowed" from previous studies, the efficiency and productivity of bilateral air liberalization, and surveys of price elasticities, frequency elasticities and travel time elasticities are also presented in Chapter 3. The methodology is described in Chapter 4. Chapter 5 describes the data, and the assumptions. In chapter 6, the empirical results obtained from model application are presented and discussed. The summary and conclusions are given in chapter 7.

Chapter 2. Current Status of Air Services between Canada and Northeast Asian Countries

As stated in the previous chapter, Canada follows a rather restrictive approach to bilateral ASAs, even with countries, such as China, Japan and Korea[5] (the Northeast Asian countries), which are the significant trade partners to Canada.

According to the Asia-Pacific Economic Cooperation (APEC) Region Trade and Investment Report (2008), 21 Pacific Rim countries or regions – referred to as "Member Economies" of APEC – accounted for approximately 40.5% of the world's population, approximately 54.2% of world GDP, and about 43.7% of the world trade in 2008. Canada, China, Japan, and Korea accounted for 26% of world GDP in 2008 (Table 2.1).

Table 2.1 The Size of the Economy of Major Countries in Pacific Rim, Measured in PPP

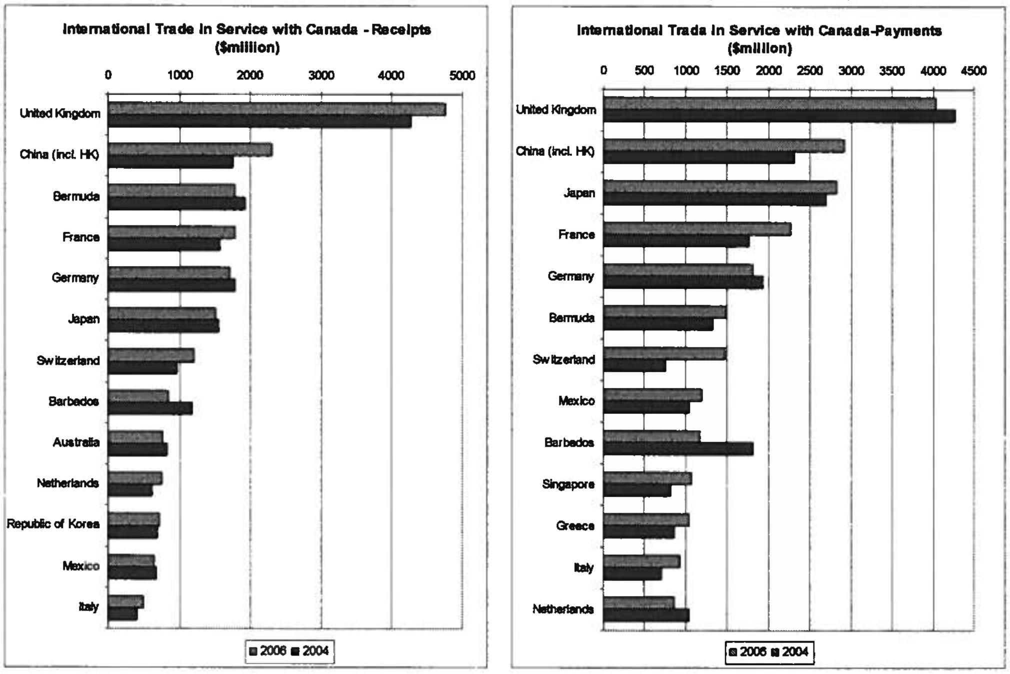
Country	Indicator	2000	2001	2002	2003	2004	2005	2006	2007	2008
Canada	GDP (int. $ billion)	851.99	887.99	929.91	967.56	1025.94	1091.57	1157.09	1217.07	1266.90
	GDP share of world total (%)	1.89	1.88	1.88	1.84	1.81	1.78	1.75	1.72	1.69
China	GDP (int. $ billion)	4959.76	5500.28	6105.57	6859.02	7768.88	8853.99	10147.33	11606.34	12988.64
	GDP share of world total (%)	11.02	11.65	12.34	13.06	13.68	14.39	15.08	15.83	16.55
Japan	GDP (int. $ billion)	3271.40	3356.06	3423.61	3545.87	3747.92	3942.21	4155.55	4346.08	4494.66
	GDP share of world total (%)	7.24	7.09	6.90	6.76	6.57	6.44	6.30	6.14	5.98
Korea	GDP (int. $ billion)	760.55	808.67	880.14	926.71	998.44	1073.97	1163.19	1250.49	1330.22
	GDP share of world total (%)	1.69	1.71	1.78	1.77	1.76	1.75	1.75	1.74	1.73
USA	GDP (int. $ billion)	9638.42	9943.74	10279.18	10761.39	11473.38	12207.78	12954.71	13543.33	14045.51
	GDP share of world total (%)	21.41	21.06	20.78	20.49	20.25	19.96	19.66	19.31	19.02

Source: Compiled from International Monetary Fund

These four countries have strong ties with each other in terms of economy, trade and culture. For example, China was Canada's No. 2 exporter and importer in 2006 (excluding the United States): over $5,000 million dollars were generated between Canada and China (including Hong Kong SAR) in terms of trade in service (Figure 2.1).

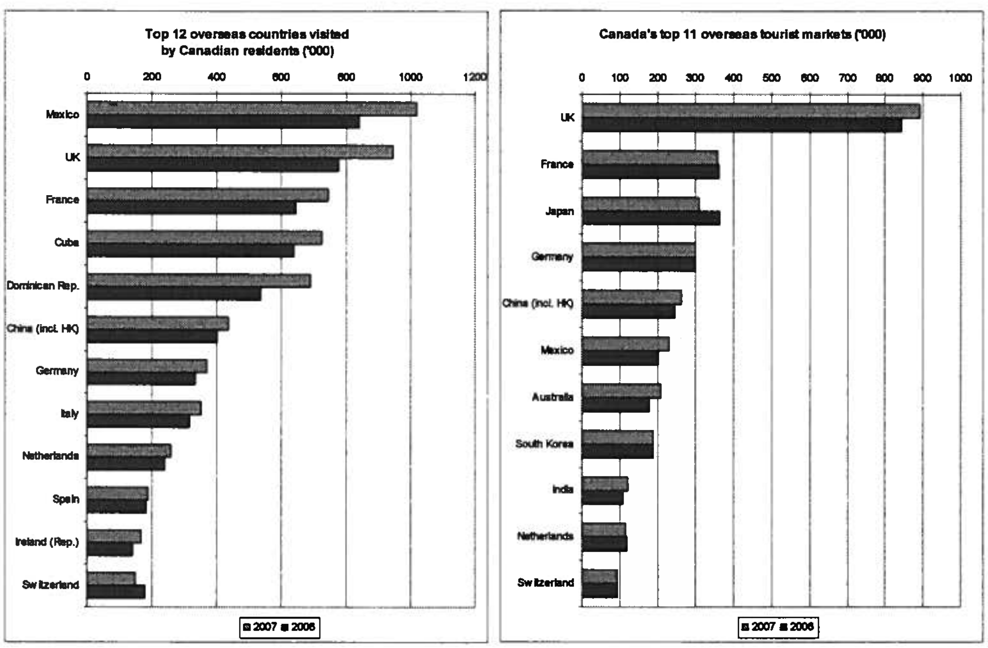
[5] Canada just concluded an Open Skies Agreement with Korea in 2009. Before the new agreement, air services between Canada and Korea were restricted.

Figure 2.1 Canada's Top Export/Import Countries, 2004/06 (excl. USA)



Source: Compiled from CANSIM II

Figure 2.2 International Travel between Canada and Other Countries



Source: Compiled from International Travel, Statistics Canada 2006-2007

Figure 2.2 shows the top overseas countries visited by Canadian residents and Canada's top overseas tourism market. In particular, over 200,000 Chinese travelers visited Canada in 2007, ranked No. 5 of Canada's top overseas tourist markets. On the other hand, over

400,000 Canadians went to China, which ranked as Canadian residents' No. 6 overseas destination in 2007.

In an address by David L. Emerson, the then Minister of the International Trade, to the Canada China Business Council in 2008, he stated that "for trading nations like Canada and China, efficient air travel is essential – not just for transporting cargo, but for stimulating trade in service and facilitating the "human links" that solidify our national partnership". Therefore, it is necessary to examine whether or not the current bilateral air services between Canada and the Northeast Asian (NEA) countries hinders the "human links".

2.1. Air Services between Canada–China

China (including Hong Kong) is Canada's second-largest trading partner with bilateral trade in service exceeding $5,000 million in 2006, and the No. 5 overseas travel market providing 262,000 visitors to Canada in 2007.

The initial framework for air services between Canada and China was set in the Civil Air Transport Agreement signed on June 11, 1973 between the two countries. This first bilateral ASA between Canada and China specified that each country would designate *one* national carrier to provide the services. Under this agreement, the Chinese carrier would operate flights between China, Vancouver and Ottawa, whereas the Canadian carrier would run services between Canada, Shanghai and Beijing. Following the restructuring of the airline industry in both China and Canada, Air China was designated as China's flag carrier in 1988, whereas Air Canada[6] was designated as Canada' flag carrier in 2000. Winnport Logistics Ltd was designated in 2000 to operate all-cargo services to China. It was replaced by Cargojet Airways Ltd in 2003. In January 2004, China Eastern was given the designation to operate passenger services between China and Canada.

On April 6, 2005, Canada's Transport Minister and International Trade Minister announced that Canada had concluded a new bilateral ASA with China. This agreement increased the air

[6] CP Air (become Canadian Airline International in 1987) was originally designated as the Canadian flag carrier. In 2001, Air Canada acquired Canadian Airline International.

transport capacity by three-fold, and the gateway cities from 3 to 9. Furthermore, two more airlines, Harmony Airways and Shanghai Airlines[7], were given the designation in the new ASA. It should be noted that tariffs are still subject to single disapproval (see Appendix A.1 for the definition). Table 2.2 compares the routes operated between the new and previous ASAs.

Table 2.2 Flight Frequencies under 2005 Canada – China ASA and Previous One[8]

Carriers/Route	Previous ASA		2005 ASA	
	Flights per week	Aircraft Type	Flights per week	Aircraft Type
Air Canada				
Toronto – Beijing	-	-	7	777
Toronto – Shanghai	-	-	7	777
Vancouver – Beijing	7	763	7	763
Vancouver – Shanghai	7	763	7	763
Air China				
Vancouver – Beijing	6	767	7	767
China Eastern Airlines				
Vancouver – Shanghai	3	A340	4	A340

Note: (1) AC recently reduces its YVR-PEK flights from daily to three times weekly, and YVR-PVG flights from daily to four times weekly.

The total number of passengers carried between Canada and China showed a dramatic increasing trend over the last decade (Figure 2.3). Although there was a 14.5% drop in 2003 due to the impact of SARS, the total traffic volume rebounded immediately in 2004. Overall, there were over 650,000 passengers carried between Canada and China in 2007, a 108.0% increase from that in 2002.

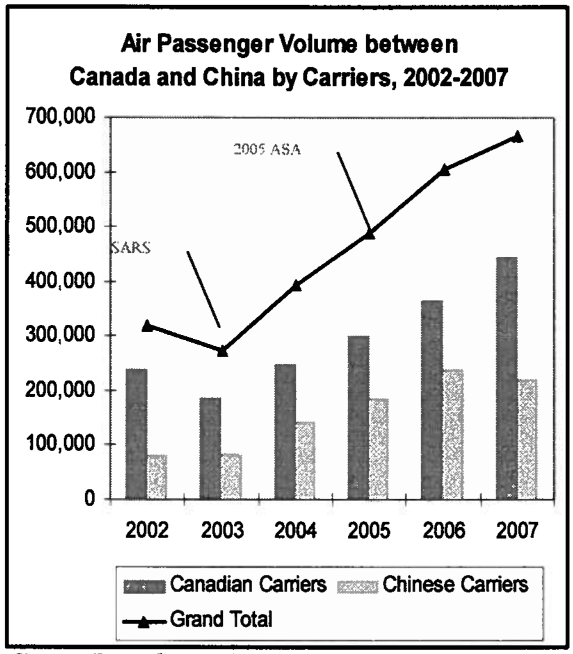
---

[7] Shanghai Airlines was designated as the Chinese flag carrier on September 17, 2007; Harmony Airways ended its scheduled flight service on April 9, 2007.

[8] Flight frequencies have been adjusted since the fourth quarter 2008 due to the effect of the global economic crisis. This also applies to other air markets (Canada – Japan, Canada – Korea).

Figure 2.3 Air Passenger Volume between Canada and China by Carriers, 1994 – 2007

Year	Canadian Carriers	Chinese Carriers	Grand Total
1994	26,108	n/a	n/a
1995	44,692	n/a	n/a
1996	51,322	n/a	n/a
1997	72,056	n/a	n/a
1998	88,184	n/a	n/a
1999	110,395	n/a	n/a
2000	121,611	n/a	n/a
2001	202,813	n/a	n/a
2002	238,013	82,397	320,410
2003	187,005	87,054	274,059
2004	247,766	144,513	392,279
2005	300,816	186,984	487,800
2006	366,675	239,028	605,703
2007	445,998	220,378	666,376



Source: Compiled from ICAO Traffic by Flight Stage Database (1994-2007)
Note: The traffic data of Chinese airlines are unavailable from 1994 to 2001.

Even though the air traffic volume increased significantly over the years under the previous and current ASAs, there are still some issues we observed. Table 2.3 presents the carrier specific average load factor from 2004 to 2006. Load factors increased in 2005 and 2006 compared to those in 2004, despite the improved flight frequency under the new 2005 ASA. With the exception of China Eastern, on the Vancouver–Shanghai route, all the flights were almost full not only during the peak seasons but also in the shoulder and even in off-peak seasons. Consequently, potential passengers may have not been able to get seats on direct flights, and therefore, forced to route their trips via Japan and/or Korea. More importantly, the entry restriction for the current ASA is still a significant deterrent to real competition in the market as Air China, Air Canada, and Shanghai Airlines (designated, but yet to launch services) are all members of the Star Alliance[9].

[9] An airline alliance is an agreement between two or more airlines to cooperate on a substantial level. Star Alliance is the world's first and largest airline alliance.

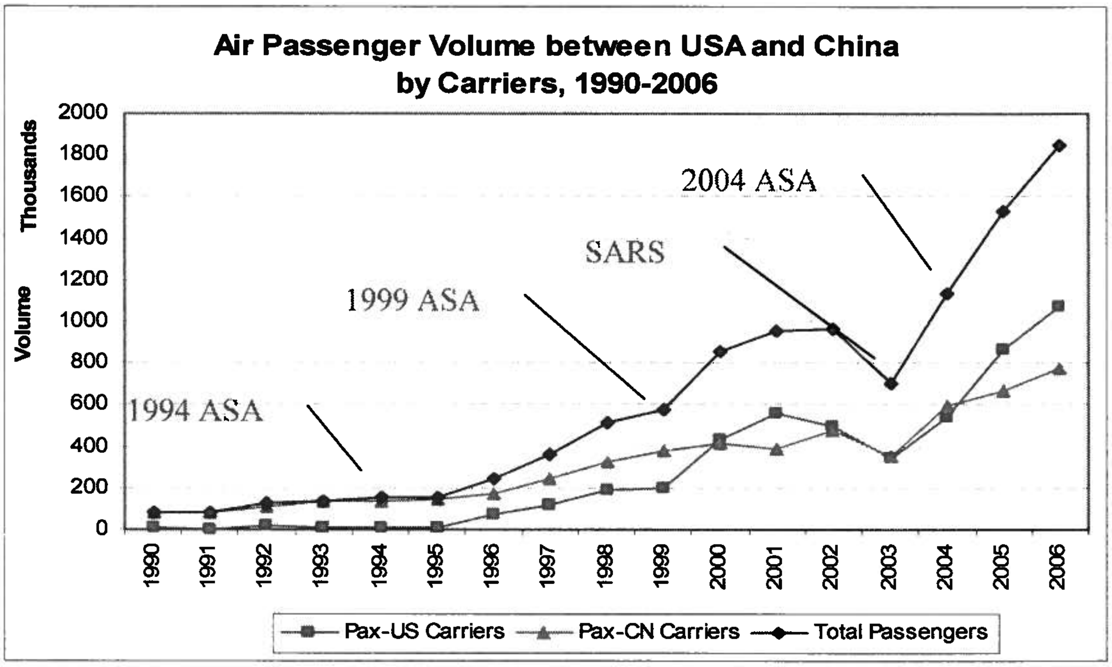
Table 2.3 The Average Load Factors in the Canada–China Markets (2004-2006)

From	To	Carriers	2004 Load Factor	2005 Load Factor	2006 Load Factor
Toronto	Beijing	Air Canada	-	79.32%	76.62%
Toronto	Shanghai	Air Canada	-	-	71.00%
Vancouver	Beijing	Air Canada	82.44%	82.72%	77.97%
		Air China	77.32%	80.75%	84.31%
Vancouver	Shanghai	Air Canada	78.41%	79.77%	77.92%
		China Eastern Airlines	54.95%	56.77%	69.43%
Beijing	Toronto	Air Canada	-	81.62%	82.71%
Shanghai	Toronto	Air Canada	-	-	89.27%
Beijing	Vancouver	Air Canada	86.81%	79.37%	79.1%
		Air China	80.15%	84.85%	86.81%
Shanghai	Vancouver	Air Canada	83.53%	83.30%	85.42%
		China Eastern Airlines	55.01%	62.56%	75.86%

Source: Compiled from ICAO Traffic by Flight Stage Database

Clearly, this new ASA is still restrictive to the growth of Canada–China air services. The liberalization between the U.S. and China would be an appropriate case to show the positive impacts on the traffic volume. Prior to 1994, only two flag carriers from each country were designated to serve the China–U.S. market under a very restrictive condition of route designation. The traffic volume between these two countries was below 200,000 per year. Then, in order to fuel economic growth, the Chinese government started liberalizing restrictive ASAs. For example, the 2004 ASA between China–U.S. agrees to increase the capacity from 37 flights per week to 121 flights per week; remove restriction on destination; and designate five more carriers to nine carriers for each side. The total number of passengers transported between these two countries increased dramatically after each ASA was signed (1994 ASA, 1999 ASA, and 2004 ASA). For example, China saw 35% traffic growth in a year after its 2004 ASA with the U.S. Clearly, any liberalization of ASA would provide more choices to the passengers and stimulate traffic growth.

Figure 2.4 The Air Passenger Volume by Carriers between U.S. and China, 1990 – 2006



Source: Complied from Bureau of Transportation Statistics, Form 41 Traffic, the United States

2.2. Air Services between Canada–Japan

Japan was Canada's No. 6 exporter and No.3 importer in 2006 (excluding the United States) with trade in service exceeding $4,000 million dollars. In addition, Japan is Canada's third most important overseas travel market. Over 300,000 Japanese tourists visited Canada in 2007.

The initial air services agreement between Canada and Japan was reached in July 1955, and has since had a number of amendments. Air Canada, Japan Airlines, and All Nippon Airways are the designated carriers under the agreement. Air Canada is allowed to serve Tokyo, Osaka and another unspecified point in Japan. Japanese carriers have the right to serve Vancouver, Toronto and one more unspecified point in Canada. Limited fifth freedom rights are included in the agreement. Airfares are subject to single disapproval (a restrictive fare regulation), and capacity is regulated.

On February 5, 2007, Canada and Japan expanded their Air Service Agreement. The current bilateral agreement provides more flexibility to airlines of both countries allowing them to adjust the capacity of their services and aircraft types. Moreover, under the new agreement, the airlines have greater route flexibility and their codeshare partner airline flights can be treated the same as their own, offering additional means of serving markets. Table 2.4 presents the direct flights between Canada and Japan as of May 2008. It should be noted that All Nippon Airways (ANA) code shares with Air Canada, but does not operate its own aircraft in the market.

Table 2.4 Flight Frequencies under Current ASA between Canada and Japan (May 2008)

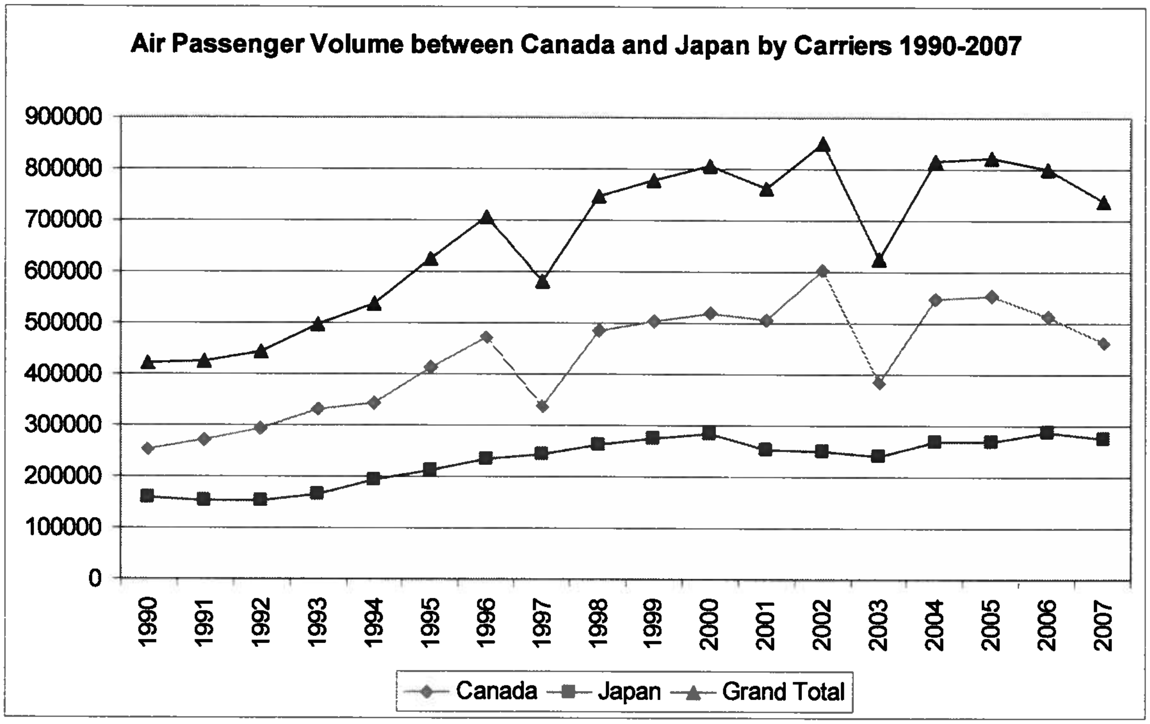
Carriers/Route	Current ASA	
	Flights per week	Aircraft Type
Air Canada		
Toronto–Narita[10]	7	777
Vancouver–Narita	7	777
Vancouver–Osaka[11]	7	767
Japan Airlines		
Vancouver–Narita	7	747

Figure 2.5 shows that the air traffic volume between Canada and Japan grew steadily from 1998 to 2002. However, there was a significant drop of traffic volume due to the regional SARS outbreak in 2003. Air traffic continued to decrease until 2007. The total passengers carried between Canada and Japan fell from 850,000 in 2002 to about 730,000 in 2007. Japanese government is one of most reluctant governments in the Pacific Rim to negotiate liberalized ASAs with other countries. Regulated by the rather restrictive ASA, the air traffic volume between Canada and Japan does not exhibit an increasing trend. A liberalized ASA would help improve the situation.

---

[10] AC reduces YYZ–NRT flight frequencies in the winter off-peak season.
[11] AC canceled YVR-KIX flight service as of Oct 24, 2008.

Figure 2.5 Air Passenger Volume between Canada and Japan by Carriers, 1990 – 2007



Source: Compiled from ICAO Traffic by Flight Stage Database(1990-2007)

2.3. Air Services between Canada–South Korea

South Korea is Canada's 8th most important overseas travel market. In 2007, about 188,000 South Koreans visited Canada. South Korea is also one of Canada's most important overseas export partners.

The existing air service agreement between Canada and South Korea became effective on September 20, 1989[12]. This ASA designated Korean Air as Korea's flag carrier and Air Canada as Canada's flag carrier to serve the Canada–South Korea air market. Under this bilateral ASA, Air Canada (code-sharing with Asiana Airlines) operates seven flights per week, and Korean Airlines operates six flights per week (Table 2.5) [13]. The seat capacity each carrier can operate is regulated. Singapore Airlines is allowed to serve three times per

---

[12] An Open Skies Agreement between these two countries was just signed on July 15, 2009

[13] Korean Air also operates two all-cargo flights per week via Anchorage.

week with its grand-fathered right to serve Vancouver via Seoul from long ago when Air Canada was serving Singapore via London[14].

Table 2.5 Flight Frequencies under Current ASA between Canada and Korea

Airlines	Routes	Aircraft Type	Weekly Frequency
Air Canada[15]	Vancouver–Incheon	Boeing 767 Airbus 340	7
Korean Air[16]	Incheon–Vancouver Incheon–Toronto	Boeing 747 or Boeing 777	3 3
Singapore Air (SIA)	(Singapore)-Incheon-Vancouver	Boeing 777	3
Total			**16 flights/wk**

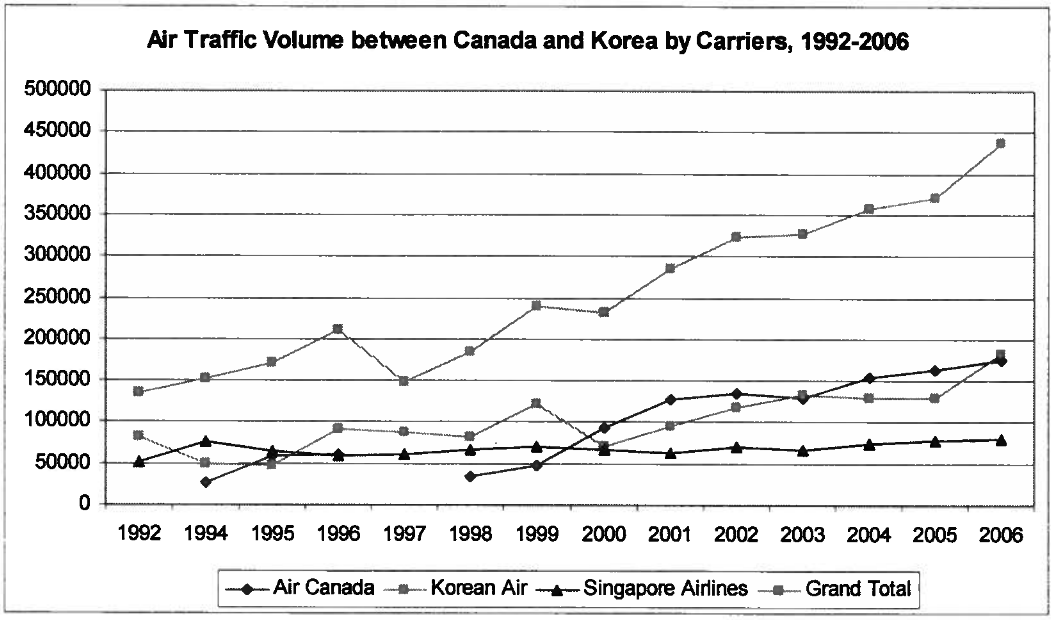
In total, the air traffic volume between Canada and Korea reached almost 450,000 in 2006, a 193% increase compared to that in 1997 (Figure 2.6). However, it is noted that less than 20% of Toronto–Korea passengers took the direct flight since there are only 3 weekly flights on the Toronto–Incheon route. This implies that the passenger choice and the traffic volume are constrained by the limitation on the flight frequencies.

[14] The Singapore - Incheon Seoul-Vancouver flight was terminated on April 25, 2009.

[15] 9 weekly flights in the peak season

[16] During summer peak seasons, Korean Air with the approval of Transport Canada has agreed to schedule two more flights weekly: one to Vancouver and another to Toronto.

Figure 2.6 Air Traffic Volume between Canada and Korea by Carriers, 1992-2006



Source: Compiled from ICAO On-Flight Origin and Destination Database(1992-2006)

It is clear that the Canada-Korea air travel market is dominated by a duopoly that are able to charge much higher prices than those in markets between Canada and most other Asian or European countries. In addition, direct air travel between Canada and Korea has been constrained by the limited number of airline seats available. We observed that the average passenger load factors of Air Canada, Korean Airlines, and Singapore Airlines in 2006 were 86.2%, 86.8% and 90%, respectively. This suggests that the Canada–Korea flights are rather full not only during peak season but also in the off-peak season. As a result, a significant proportion of Korean travelers choose to route their trips to Canada via U.S. airports because of lower airfares and more seats made possible by the 1998 Korea–U.S. Open Skies Agreement[17]. Obviously, the restrictive air services agreement between Canada and Korea is a major constraining factor for travel between the two countries.

2.4. Summary

In this chapter, we examined the current status of air services in Canada–China, Canada–Japan and Canada–Korea bilateral markets. The air services between Canada and

[17] It is noted that Korean citizens need US transit visa to route their travel via US airports. This markedly reduces Koreans routing their travel to Canada via the US.

China/Japan are regulated by restrictive bilateral Air Services Agreements, and the air services between Canada and Korea were highly regulated until an Open Skies was signed in July 2009. These restrictive ASAs hinder the further growth of tourism and trade. Liberalization of bilateral ASAs would remove the restrictions on price, frequency and capacity, which would bring potential passengers into the markets, especially for the Canada–China market where China has the advantage of fast economic growth and large population, due to the increasing consumer choice. The liberalization of air services between China and the United States presented in section 2.1 would be a good example to show how liberalization positively impacted on the market, even with continuing restrictions.

Chapter 3. Literature Review

There have been many studies conducted on the economic effects of air transport liberalization and/or deregulation. Most of the earlier researches focused on the economic effects of air deregulation on the domestic market. These studies suggest that air deregulation would change the market structure and have significant impacts on price and output. With the increasing trend of bilateral air services liberalization, more recent studies have focused on the economic effects of bilateral air services liberalization in the international markets. Most of these studies are empirical studies which, based on the historical data, compare market outcomes before and after bilateral liberalization, or compare liberalized routes with routes subject to restrictive bilaterals. Only a few studies have tried to measure the potential economic effects of bilateral air services liberalization with simulation models. Despite of the different methodologies, almost all the studies found that liberalization of bilateral air services would lead to increased competition, higher market outputs and better service quality.

We start this chapter by introducing key empirical studies on the impacts of air transport deregulation. Although these studies focus on the domestic, they still offer valuable insights on the effects of air transport liberalization in general. We then focus on the review of important literature on bilateral air services liberalization, including empirical research and analytical studies. This chapter also provides a summary of the effects of air deregulation/liberalization on airlines' productivity and efficiency, and a survey of demand elasticities and value of travel. The findings from these studies will be used as parameters in the simulation model in Chapter 5.

3.1. Economic Effects of Air Deregulation/Liberalization

As mentioned above, the earlier studies, which examined the impacts of domestic air transport deregulation, offer general insights on the economic effects of bilateral air services liberalization. We start introducing the key findings from these studies.

3.1.1. Key Empirical Studies on the Impacts of Air Transport Deregulation

It is commonly believed that air transport deregulation leads to lower airfare, and consequently increased traffic volume. Douglas & Miller (1974a) and Keeler (1972) provided convincing support for this belief by finding that airfares under regulatory restriction were significantly higher than those in competitive market.

Audretsch and Mata (1995) argued that air transport deregulation can be treated as an entry as it allows new entrants and increases competition by removing restrictions on air services. The entry forced prices to fall, which increased output. Similarly, Joskow, Werden and Johnson (1994) found that an entry reduces airfares and increases traffic, and vice versa. From the US domestic quarterly data on major non-stop city-pairs during the period of 1985-1987, they observed that incumbent carriers would cut prices to maintain traffic in response to an entry; and survivor(s) would increase price in response to an exit. Hazledine, Green and Haugh (2003) constructed an oligopoly model with linear demand functions to identify the changes in the competitive nature over periods when a new firm entered the market. They found that incumbents' behaviour was close to Cournot-Nash without the new entrant. However, the market become much more competitive when there was a new entrant.

Hurdle et al. (1989) estimated the impact of potential entry on yields on routes to/from major hubs by controlling stage length, market concentration, etc. They found that average route specific yields increased by 12% to 33% when one of the carriers withdrew on a duopoly route. Abunassar and Koford (1994) found that airfares were 10% higher in a monopoly market than in a less concentrated market. Oum, Zhang and Zhang (1993) estimated that the price would be 17% higher on monopoly routes than on duopoly routes. Using a more recent dataset (1993, 1997, 2002), Hofer, Dresner and Windle (2004) reached a similar conclusion that the market concentration is positively correlated to the average fare.

The key findings of these studies suggest that air deregulation changed the market structure from monopoly to duopoly or even competitive markets. Therefore, the airfare decreased and more passengers were attracted as a result.

3.1.2. Empirical Studies on Economic Effects of Bilateral ASA Liberalization

As shown above, air deregulation would reduce airfares and increase air traffic. In addition, it has been widely accepted that bilateral air services liberalization would also reduce average airfares and airline costs and improve air service quality, which would benefit consumers, and improve social welfare,

Dresner and Tretheway (1992) developed a set of neoclassical profit-maximizing equations to estimate prices across air routes under the assumptions of Bertrand competitive type behaviours and collusive behaviour by firms. Based on the monthly data for March and September during the period of 1976 to 1981 on 51 unidirectional long-distance international routes, they found that air liberalization reduced discount air fares by an average of 35%, which was estimated to result in a welfare gain of roughly $325 million in 1981. However, their results indicated that air liberalization had no statistically significant effect on the "full fare".

Maillebiau and Hansen (1995) estimated the demand and consumer welfare impacts of air liberalization in North Atlantic air markets (U.S. – France, Germany, Italy and Netherlands). Using a demand model, a yield (pricing model), and an accessibility model, they found that air liberalization would increase air traffic volume by 56%; reduce airfares by 35%; increase air service accessibility by 44%; and generate an additional $5.1 billion in consumer benefits (or $585 per traveller in 1989).

Dresner and Oum (1998) conducted a case study of Canada to test the effects of air liberalization. Based on the data from both Statistics Canada (1975-94) and the U.S. Department of Transportation (1977-94), they investigated how both Canada's and U.S. liberal air agreements affected the Canadian air transport industry. Their results showed that the existence of a Canadian liberal bilateral air service agreement (Canada – Netherlands, Canada – U.K., or Canada – Germany) increased the number of air passengers travelling directly to Canada from a country, who has signed a liberal agreement with Canada, by 7,100 to 9,000 passengers on average. On the other hand, the existence of a U.S. liberal agreement decreased the direct air traffic to Canada by 2,800 to 3,500 on average, from a country who had a liberal agreement with the U.S. The study also indicated that U.S. liberal bilaterals diverted passengers from direct air routes to/from Canada to routes that pass through the U.S. The study suggested that further liberalizing air services agreements would be an effective way to expand Canadian international air market.

Schipper, Rietveld, and Nijkamp (2002) constructed a set of demand, fare, and frequency functions to estimate the effects of air liberalization in the European market, based on a sample of 34 European inter-state routes with varying liberalization status during the period 1988 to 1992. They used a two-stage least squares (2SLS) procedure, with passengers, airfares and frequency as endogenous variables. They found that full air liberalization led to a 34% reduction in standard economy airfares and a 69% increase in departure frequencies. In addition, they estimated that consumer welfare associated with the full bilateral liberalization would be €666 million or €346 per passenger.

InterVISTAS (2006) attempted to quantify the benefits of air liberalization in a number of specific route(s), and to explain variations in the passenger traffic by different levels of air liberalization. They estimated that the single EU market generated 44 million additional international passengers, which increased the intra-EU traffic by 4-6% yearly. The air liberalization also contributed an increase of 1.4 million fulltime equivalent employment and an additional $85 billion in GDP to the intra-EU air transport market. The study also found that air liberalization in the Trans-Tasman market increased air passengers by 56%, full time equivalent employments by 20,600, and GDP by $726 million.

In summary, previous studies have found that international air liberalization had a significant economic effect, leading to an average 34%-35% decrease in economy airfare. However, the level of increase in air passenger volume and flight frequency depends on specific market characterises.

3.1.3. Modeling the Potential Economic Effects of ASA Liberalization

Most of the previous studies have used various forms of regression analysis, or paired comparison of prices from routes with similar stage length or density, to identify and estimate the effects of air liberalization. Such approaches would not be able to provide immediate guidance to policy makers in formulating country (or region) specific policies since each country (or region) faces unique situation in terms of home carrier competitiveness, input prices, domestic market size and growth potential, geographic location of hub airports, and substitution with other transport modes etc.

A few studies took a different approach, in that they introduced an equilibrium model with which market outcomes can be simulated, *ex ante,* for alternative policy scenarios.

Gillen, Harris and Oum (2002) developed a bilateral ASA model, and applied it to measure the economic effects of liberalizing the Canada – Japan bilateral ASA.[18] They adopted the Armington assumption[19] in their demand model, where the idea of variety and nationally differentiated products were introduced. Their simulations of removing bilateral restrictions on price, frequency and airline entry in the Canada–Japan market indicated an approximately $32.7 million aggregate economic gain and a 50% increase in traffic volume. However, although the competitive market structure remained in their Armington model, the degree of competition was preset before the simulation according to the previous studies. It means their model failed to simulate the effects internally with respect to the degree of competition.

The Productivity Commission (1999) developed a network model of routes between Australia and Asian countries. They predicted a 4.4% reduction in price and a 2.6% increase of traffic volume for the Australia – China air liberalization. Although the model considered air service quality, airline network and airline behaviour, it failed to measure the effects of air liberalization with new entrants. In addition, the model was only capable of simulating the

---

18 The HLB Study (1996) conducted for Transport Canada in cooperation with Gillen, Harris and Oum reports application of their bilateral ASA model to Canada's ASAs with Germany and Australia as well as with Japan.

19 Armington (1969) introduced an assumption that final products traded internationally are differentiated on the basis of the location of production. He assumed that in any one country each industry produces only one product and that this product is distinct from the product of the same industry from any other country. The Armington assumption of nationally differentiated products has been widely adopted in global computable general equilibrium (CGE) models to define demands for domestically produced and imported goods (Lloyd and Zhang, 2006).

results under the price-setting behaviour, thus it can only measure the effect of air liberalization partially.

Gillen and Hinsch (2001) conducted simulations to examine the effects of liberalizing the German international aviation market. They estimated that number of passengers would increase by 165,970 with 17,000 as transfer passengers, and airport revenues would increase by 6%; and the number of new tourists would increase by 11,000. However, similar to Gillen, Harris and Oum (2002), the model does not allow explicit changes in the degree of competition.

Booz Allen Hamilton (2007) conducted an analysis of the potential economic benefits from establishing an Open Aviation Area (OAA) between European Union and the United States. They constructed a simple Cobb-Douglas demand model to calculate the changes in traffic volume and consumer surplus after liberalization. The study made assumptions of possible price reductions based on the results of other studies. They estimated that, under the scenario with a 28% price decrease and a demand elasticity of -2.5 (their upper bound scenario)[20], the EU-US air traffic volume would increase by over 1 million (127% increase) for the first year Post-Liberalization to the traffic of over 2 million. Also, they estimated that the consumer surplus would increase by €335 million. However, this model does not consider flight frequency and other service quality factors.

Adler and Hashai (2005) estimated how the inter-regional passenger flows in the Middle East would change under an open skies policy. Although they attempted to adopt the hub and spoke network in their analysis, they were not able to formulate a micro-level model because of data limitation. They adopted a gravity model developed by Doganis (2002) instead.

In summary, most of the previous modeling studies simulated the potential economic effects by constructing a demand model. They concurred with the empirical studies in the economic

---

[20] Under their lower bound scenario (an 18% price decrease and a demand elasticity of -1), the traffic volume would increase by around 240,000 (22% increase) for the first year Post-Liberalization to the traffic of 1.3 million.

effects of bilateral air services liberalization. With bilateral liberalization, the air traffic would increase, not only because the airfare would reduce caused by air liberalization, but also because the demand curve becomes flatter, which means more price elastic in the deregulated market. However, the common limitation of these studies is they can not simulate the degree of competition internally.

3.2. Extended Review of Related Studies

As mentioned at the beginning of this chapter, we decide to include a review of the effects of deregulation/liberalization on airlines' productivity and efficiency, and a survey of demand elasticities and the value of travel time as the findings were used in our simulated model. These studies will be presented in this section.

3.2.1. The Effects of Deregulation /Liberalization on Productivity & Efficiency

One of the main rationales for deregulation is to improve the productivity and efficiency of the airlines. There have been numerous studies on the effects of deregulation/liberalization on airline performance. For example, Forsyth (1997) concluded that productivity improvement and cost reduction were the main sources of welfare gain from liberalization. Caves, Christensen and Tretheway (1983) found that airline productivity growth accelerated from 2.8% per year to 5.1% per year after the US deregulation, using translog multilateral comparisons of output, input and TFP.

Comparing the changes in average costs with the changes in average input prices from 1971 to the second quarter of 1981, Bailey, Graham and Kaplan (1985) found that the deregulation increased aircraft utilization, seating density, and stage lengths, consequently contributing to a higher productivity growth. In particular, they found that the productivity growth of trunk airlines increased from 1.5% per year between 1971 and 1975 to 2.4% per year between 1975 and 1981.

Marin (1995) evaluated the impact of liberal air services agreements (ASA) in some European markets in terms of price competition and market structure. He argued that airlines were subject to free riding problems (airlines share the market equally at the same price level, and do not have the motive to differentiate their products) under the restrictive ASAs, thus there was no incentive for individual carriers to improve efficiency. He further argued that air liberalization had resulted in greater competition in price and service quality, which would force airlines to exploit their cost advantage and to improve efficiency.

Oum and Yu (1995) compared unit cost competitiveness of the world's 23 major airlines over the 1986-93 periods. By comparing the "residual Total Factor Productivity (TFP)" across airlines and over time, they concluded that "as liberalization of the airline industry continues, efficiency will become progressively more important in determining cost competitiveness of an airline". In addition, their comparison indicated that European aviation liberalization that began in 1987 produced substantial productivity gains.

Although majority of the studies have concluded that deregulation/liberalization have improved airline productivity significantly, there are a few researchers who have challenged such findings. For example, Koran (1983) argued that "the fall in average costs due to the changes in flights, load factor and aircraft utilization rates do not represent a true increase in productivity". He stated that the air services an airline provided in 1978 was not the same as the services provided in 1976. However, he claimed that deregulation did result in lower average costs.

Most of the previous studies suggested that air deregulation/liberalization would improve the productivity and efficiency. In addition, they all agreed that the air deregulation/liberalization would decrease the airlines' costs. Therefore, during the simulation, it is expected there would be a cost reduction with introducing air liberalization.

3.2.2. Demand Elasticities and Value of Travel Time

It is important to understand the various elasticities for air travel in order to measure the economic effects of ASA liberalization, as they will be used in the simulating model. Therefore, this sub-section summaries the key elasticity estimates from previous studies.

Oum, Waters, and Yong (1992) conducted a thorough survey of price elasticities of transport demand. They found that price elasticity estimates for air travel "range from -0.4 to -4.51, with the majority of the figures falling within -0.8 and -2.0". An updated survey by Oum, Waters, and Fu (2006) showed that the price elasticity estimates range from -0.4 to -4.6 for leisure travellers and from -0.08 to -4.18 for business travellers. Gillen, Morrison, and Steward (2003) reviewed 254 price elasticity estimates from 21 studies and found that the price elasticities for air travel range from -0.14 to -2.7 for the long-haul international leisure travel and from -0.01 to -2.0 for the long-haul international business travel. They also found that price elasticity for the long-haul international travel is lower than that for the domestic travel.

Compared to the studies of price elasticity, very limited estimates of frequency elasticity are available from the literature, especially for the international market. Most of the previous studies have suggested the reasonable values of frequency elasticity should be very low. For examples, Morrison and Winston (1986) found that that in the U.S. market, flight frequency elasticity was 0.21 for business travellers and 0.05 for leisure travelers. Basar and Bhat (2004) estimated that the frequency elasticity ranges from 0.17 to 0.55 in the San Francisco Bay area; Schipper, Nijkamp and Rietveld (2007) suggest that the frequency elasticity is 0.41 under a monopoly regime. However, there are a few studies found that the high values of flight frequency elasticities. Ippolito (1981) reached a flight frequency elasticity estimate of 0.864 in the U.S. domestic market by constructing a Two-Stage Least Squares (2SLS) estimate of airline demand and a 2SLS estimate of seat supply. His finding may not reveal the true story because seat supply is not included as an independent variable in the airline demand equation. The result is likely to be different if a 2SLS estimate of airline demand and a 2SLS estimate of flight frequency were applied. Schipper, Rietveld, and Nijkamp (2002) obtained a high frequency elasticity estimate of 0.77 based on a sample of 34 European interstate city-pair markets for the period 1988 to 1992. However, their results appeared to be over-estimated, as they did not consider airfare in their frequency equation.

Flight time and access time have been recognized as significant factors in the air travel choice (Harvey, 1987; Ashford and Bencheman, 1987; Thompson and Caves, 1993; Brooke, Caves and Pitfield, 1994; Furuichi and Koppelman, 1994; etc.). Most of the previous studies have applied the Multinomial logit model (MNL) and/or the mixed multinomial logit model (MMNL) in assessing the value of time air travellers placed on their flight time and/or access time. Pels, Nijkamp and Rietveld (2001) conducted an empirical analysis of passenger choice in the San Francisco Bay area. Based on the 1995 Metropolitan Transportation Commission (MTC) airline passenger survey, they estimated the access time elasticity was -0.37 for business passengers, and -0.32 for leisure passengers. Based on the same data as Pels et al, Hess and Polak (2005) studied the trade-offs between access-time and air fare, and estimated the value of time at $3.73/min for leisure visitors and $4.56/min for business passengers. However, the authors stated that "the calculated trade-offs should not be seen as an estimate of the value of access time reduction, given the use of air fare rather than the access cost coefficients". The relatively poor quality of the fare data (low airfare being used) would result in overestimated values. Hess (2007) used a 2005 stated preference (SP) data collected from the Internet by Resource Systems Group to study the air travel choice behaviour in the U.S. market. He found a negative correlation between air fare and access time as well as between air fare and flight time. According to his calculation, the willingness to pay (WTP) is $28.07/hour for reductions in flight time and $23.81/hour for reductions in access time.

In this sub-section, we provide a survey of demand elasticities. Most of the previous studies suggested air passengers are sensitive to the price, and they are insensitive to the frequency. In addition, the previous studies of travel time are presented in order to show the trade-offs between travel time and airfares. They showed that travel time is a significant factor when air passengers consider the air travel choice (for example, non-stop flight vs. one-stop flight).

3.3. Summary

Results from previous studies indicate that ASA liberalization increases the competition among airlines, which would force airlines to reduce airfares and increase flight capacity. Passengers will benefit from the reduction in airfares and the increase in capacity (frequency, new entrants), whereas carriers would have to improve their productivity and efficiency in order to maintain and/or improve their competitive positions. Table 3.1 and Table 3.2 provide a summary of the studies reviewed in this chapter.

However, most of the studies were empirical researches. Such approach would not provide immediate guidance for a specific bilateral case since each country has unique situation. Although there are a few studies that have attempted to simulate the potential economic effects of bilateral air services liberalization, they are either preliminary or failed to take into account of the degree of competition in their simulation model. The degree of competition varies over a wide range across different markets or even among different routes. In order to capture the market structure among different markets and routes, therefore, it is necessary for a simulation model to incorporate the degree of competition explicitly. This thesis attempts to develop a computable model that can estimate the economic effects of bilateral liberalization under the *Cournot* Competition market, *Bertrand* Competition market, or somewhere in between.

Table 3.1 Summary of Studies on Air Deregulation and Liberalization

Topics	Studies	Empirical Results
Impacts of Air Transport Deregulation	Hurdle et al. (1989)	Average yield increases 12%-33% when # of carriers reduces from 2 to 1
	Joskow et al. (1994)	Entry reduces fares and increases outputs, vice versa
	Abunassar and Koford (1994)	Airfares are 10% higher in a monopoly market
	Oum, Zhang and Zhang (1993)	Airfares are 17% higher moving from duopoly to monopoly routes
Economic Effects of Bilateral Air Services Liberalization	Dresner and Tretheway (1992)	Discount air fares reduce by an average of 35%; welfare would gain roughly $325 million in 1981 alone
	Koran (1983)	Airline fare deregulation resulted in an increase in consumer's surplus of between fifteen and twenty dollars per round trip
	Dresner and Oum (1998)	U.S. liberal bilaterals diverted passengers from direct air routes to Canada to routes that pass through the U.S.
	Maillebiau and Hansen (1995)	Air traffic volume would increase 56%; airfare would reduce 35%; the accessibility would increase 44%; and consumer benefits would be $5.1 billion, or $585 per traveller for year 1989 only
	Schipper et al (2002)	The standard economy airfares are 34% lower; the departure frequencies are 69% higher; the consumer welfare would be 666 million ECU or 346 ECU per passenger
	InterVISTAS (2006)	The air liberalization would increase the traffic and employments, and generate additional GDP.
Modeling the Economic Effects of Air Liberalization	Gillen, Harris and Oum (2002)	Removing restrictions would show an approximately $32.7 million aggregate economic gain and an increase in traffic volume by 50% for Canada – Japan case
	Productivity Commission (1998)	The estimation shows a 2.6% increase of traffic and a 4.4% decrease of airfares for Australia – China case
	Gillen and Hinsch (2001)	They estimate the route passenger would increase by 165,970, the airport revenue increases by 6%, and it would generate new jobs for German case
	Booz et al (2007)	The OAA would increase the traffic by over 1 million for the first year, and the consumer surplus by 335 million.

Table 3.2 Summary of Extended Review of Related Studies

Topics	Studies	Findings
Efficiency and Productivity	Caves, et al (1983)	The productivity growth accelerated from 2.8% per year to 5.1% per year due to the deregulation of US air transport market
	Bailey, Graham and Kaplan (1985)	Air deregulation in U.S increased aircraft utilization, seating density, and stage lengths, and then has contributed to a higher growth rate in productivity
	Marin (1995)	Liberalization has resulted greater competition in price and services quality, which would force airlines to exploit their cost advantage and improve efficiency
	Oum and Yu (1995)	As liberalization continues, efficiency will become progressively more important in determining cost competitiveness of an airline
Airfare Elasticities	Oum, Waters, and Yong (1992)	Range from -0.4 to -4.51, with the majority of the figures falling within -0.8 and -2.0
	Oum, Waters, and Fu (2006)	Range from -0.4 to 4.6 for leisure travellers and from -0.08 to -4.18 for business travellers
Flight Frequency Elasticities	Morrison and Winston (1986)	The business frequency elasticity: 0.21 The leisure frequency elasticity: 0.05
	Basar and Bhat (2004)	Range from 0.17 to 0.55
	Ippolito (1981)	A high frequency elasticity of 0.864
	Schipper et al (2002)	A high frequency elasticity of 0.77
Travel Time Elasticity or Value of Travel Time	Pels et al (1998)	Access time elasticity: -0.42 for business passengers, and -0.62 for leisure passengers
	Hess and Polak (2005)	High values of access time of \$3.73/min for leisure visitors and \$4.56/min for business passengers
	Hess (2007)	The WTP for reductions in flight time is \$28.07/hour, and for reductions in access time is \$23.81/hour

Chapter 4. Methodology

In order to measure the effects of change in a bilateral Air Services Agreement (ASA), one needs to specify demand and supply functions, and the market clearing conditions in such a way that the equilibrium prices and quantities can be computed. In this chapter we develop a model that allows simultaneous changes in price, passenger volume, and flight frequency at competitive equilibrium in an oligopolistic market in which airlines are assumed to use seats and flight frequency as strategic tools for competition.

As we discussed in the literature review, a limited number of studies, including Gillen, Harris and Oum (2002), attempted to build models to estimate the potential economic effects of bilateral ASA liberalization. Gillen, Harris and Oum (2002) constructed an "Armington" demand model[21] that incorporates consumer's choice utility function. The model was used to estimate the potential economic effects under different scenarios of ASA liberalization:

- Capacity deregulation while keeping price regulated
- Price deregulation while keeping capacity restriction
- Price and capacity deregulation without allowing new entry
- Full transboader open skies: deregulation of price, capacity & new entry

Our simulation model starts with the airlines profit maximization function, and introduces a conduct parameter (σ) which is a measure of degree of competition. It allows us to examine the effects under the *Cournot* competition market ($\sigma = 0$), the *Bertrand* competition market ($\sigma = -1$) and somewhere in between, and measure airlines behaviour under different degree of competition internally.

As stated by Gillen, Harris and Oum (2002), the simulation model "must integrate all the routing possibilities for each Origin – Destination (OD) market for all OD markets in the network. The starting point is to identify all OD markets in the region, and then, map the alternative routings for each OD pair".

---

[21] Armington (1969) introduces the idea of nationally differentiated products to the international trade. He assumes each industry in any one country produces one product which is distinct from the product of the same industry from any other countries. Consumers choose a different variety of products (imperfect substitutes) based on their preference.

Ideally, the simulation model should capture effects of change in a bilateral ASA on:
(1) the origin-destination traffic between the two countries, say, country A and country B,
(2) the transit traffic coming from behind country A (B), say from country C to go to country B (A) or to a point beyond country B via country A (B),
(3) pure through traffic traveling between countries C and D with connections at country A and country B.

However, because of the time and resource limitations and the limited data availability we are forced to limit our analysis only to the total traffic volume between two airports such as the total passenger volume between Vancouver (YVR) and Shanghai-Pudong (PVG). Although this traffic volume is consisting of:
(1) Vancouver-Shanghai origin-destination traffic,
(2) the traffic originating from other cities in Canada, US, Mexico or other countries traveling to Shanghai (PVG) or beyond via Vancouver (YVR),
(3) the traffic originating from other cities in China and other Asian countries traveling to Vancouver (YVR) or beyond via Shanghai (PVG).
We are not able to distinguish traffic volume (2) and (3) as having different origins and/or destinations from (1) Vancouver-Shanghai origin-destination traffic. Therefore, our model treats all of the traffic (1), (2) and (3) as Vancouver-Shanghai origin-destination traffic. And as a result, the estimated effects of air liberalization to be shown in Chapter 6 would be underestimated since this study does not take into account of the traffic beyond and/or behind the OD traffic.

The Figure 4.1 presents alternative route-carrier combinations available for the Vancouver-Shanghai OD travelers to choose under the current Canada-China bilateral ASA:

Direct Route-Carrier Combinations:

YVR – PVG (Shanghai), China Eastern (MU) non-stop services

YVR – PVG, Air Canada (AC) non-stop services

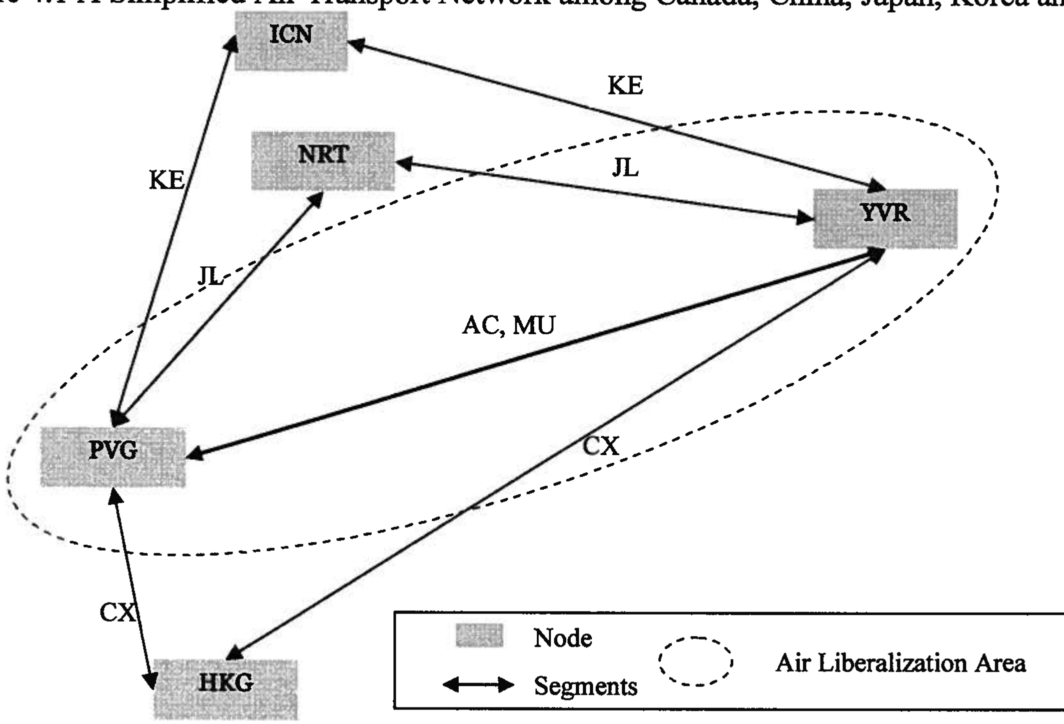
One-Stop (Indirect) Route-Carrier Combinations:

YVR – ICN – PVG one-stop services by Korean Air (KE)

YVR – NRT – PVG one-stop services by Japan Airlines (JL)

YVR – HKG – PVG one-stop services by Cathay Pacific (CX)

Figure 4.1 A Simplified Air Transport Network among Canada, China, Japan, Korea and U.S.



In our model, each of the Vancouver-Shanghai OD passengers are assumed to choose one of the five route-carrier combinations in Figure 4.1 based on airfare, flight frequency, and travel time.

Liberalization of the bilateral Canada – China ASA is likely to increase air passenger number linking Vancouver-Shanghai as well as to lead to changes in airfares, flight frequencies and transit time. Because a bilateral liberalization would improve quality level of the air services including flight frequency, the demand curve would shift to the right. This means that air travel volume would increase even in the absence of any price reduction. In addition, since a greater variety of alternative airline-route combinations become available for a given pair of cities (airports), there will be increased competition in the market. This increase in competition would lower price,[22] and thus, further increase travel volume. Our model will attempt to quantify and compare these expected outcomes under different degrees of ASA liberalization including the status quo.

It is also expected that Canada – China bilateral liberalization would divert some portion of the air traffic on the indirect routes to the Vancouver – Shanghai route. If one or more new carriers initiate a direct service, there would be another direct route-carrier combination available for Vancouver-Shanghai travelers to choose. Therefore, the model needs to incorporate all these rerouting possibilities for this Origin-Destination market.

Our simulation model is specified as the following:

Air transport demand q for an OD route is defined in a Cobb-Douglas form as:[23]

$$q = ap^b f^c \qquad (4.1)$$

where q is total yearly passenger volume for the OD market, p is market average airfare in the year, f is annual total frequency of all route-carrier combinations serving the origin-destination market being modeled, and b and c are price and frequency elasticities, respectively, of air travel demand in the origin-destination market.

Given the market travel quantity demand in equation (4.1), the inverse demand function can be derived as:

$$p = \left(\frac{q}{af^c}\right)^{\frac{1}{b}} \qquad (4.2)$$

Assume that there are J route-carrier combinations in the market, and each route-carrier combination has different annual frequencies, the total travel volume *(q)* and frequencies *(f)* offered on the OD market can be written as:

---

[22] The increased competition would lead to lower price primarily because of two reasons: airlines face an increased pressure to improve cost efficiency and to reduce mark-ups.
[23] A Cobb-Douglas demand function is a special case of CES (Constant Elasticity of Substitution) function where elasticity of substitution is limited to 1.0.

$$q = \sum_{i=1}^{J} q_i \tag{4.3}$$

$$f = \sum_{i=1}^{J} f_i \tag{4.4}$$

Each route-carrier i would then maximize its profit, subject to the inverse demand function, as shown in the following equation (4.5):

$$\pi_i = \max_{q_i} \left(p_i q_i - C_i \right) \tag{4.5}$$

The p_i, an airline i's average airfare, is defined as the following:

$$\begin{aligned} & p_i + \left(d_i - d \right) = \eta_i p \\ & \Rightarrow p_i = \eta_i \left(\frac{q}{af^c} \right)^{\frac{1}{b}} - \Delta d_i \end{aligned} \tag{4.6}$$

where η_i is the value of quality index[24] for route-carrier combination *i*. Obviously, passengers would prefer the airline with higher quality, given other factors constant. To be specific, η_i can be written as the following relative index form as compared to the average value of the all airlines' quality levels:

$$\eta_i = \frac{\text{airline i's actual quality rate}}{\text{average of airlines' actual quality rate}} \tag{4.7}$$

The higher the value of the quality index of an airline, the higher is the average airfare that the airline is able to charge to the passengers.

d in equation (4.6) is the market average value of the passenger's willingness to pay (WTP), and *di* is the WTP to route-carrier *i*. Therefore, Δdi is the travelers' additional WTP (can be positive or negative) for the time saving by flying with route-carrier *i*. It means the passengers are willing to pay higher than the average market price for the route-carrier that has shorter travel time.

[24] The actual quality rate can be obtained from the World Airline Star Rating programme conducted by SKYTRAX, examining the product and service delivery for each airline.

ci in equation (4.5) is the cost function for carrier-route *i*. Any given OD market can be served by a number of route-carrier combinations, some of which (indirect routes) can have more than one flight segment. Therefore, it is reasonable to set the flight segment as the base unit for our cost function. By adopting the segment cost function used in Gillen, Harris and Oum (2002), we define the flight segment cost function for route-carrier *i* as follows:

$$c_i = w_i q_i + v_i f_i \tag{4.8}$$

The segment cost function in Equation (4.8) has two parts: passenger cost (the first term) and the flight operating cost (second term). Notice that w_i and v_i are unit cost per passenger and unit cost per flight, respectively.

Gillen and Hazledine (2006) point out that route distance is used as a proxy of costs in most airline pricing studies. Using aircraft operational engineering data, Swan and Adler (2006) specify the flight costs as a function of seat numbers and route distance. Nevertheless, although route distance is an important determinant of flight cost, other factors such as aircraft type, wage and overall operating efficiency also play significant roles in flight costs. The flight costs, stated by Gillen and Hazledine, can be measured by the cost per block hour multiplied by the number of block hours required for the route.[25] Due to availability of the block hour cost data, in this research, we adopt the block hour cost approach for calculating the flight operating cost.

Substituting equation (4.8) into (4.5), one can obtain:

$$\pi_i = \max_{q_i} \left\{ \left(\eta_i \left(\frac{q}{af^c} \right)^{\frac{1}{b}} - \Delta d_i \right) \cdot q_i - w_i q_i - v_i f_i \right\} \tag{4.9}$$

[25] The block hour costs depend on the labour cost and other input prices of each carrier. The "block hour" are measured based on Form 41 cost data collected by the USDOT.

For a given aircraft type and an assumed value of load factor, the number of passengers carried by airline i can determined as follows:[26]

$$q_i = L_i Z_i f_i \tag{4.10}$$

where L_i is average load factor airline i achieves on a route, Z_i is number of seats per aircraft that airline i operates on that route.

By substituting equation (4.10) into equation (4.9), the profit function can be rewritten as follows:

$$\pi_i = \max_{q_i} \left\{ \left(\eta_i \left(\frac{q}{a\left(\sum \frac{q_i}{LZ}\right)^c} \right)^{\frac{1}{b}} - \Delta d_i \right) \cdot q_i - w_i q_i - v_i \frac{q_i}{L_i Z_i} \right\} \tag{4.11}$$

A route-carrier combination i will carry passengers at rate q_i in order to maximize its profit. Using differential calculus with respect to q_i, one can calculate the following first-order condition (FOC) for a route-carrier combination i,

$$\begin{aligned} \frac{\partial \pi_i}{\partial q_i} &= \frac{1}{b} p\left(1+\sigma^i\right)\frac{q_i}{q} - \frac{c}{b} p\left(1+\sigma^i\right)\frac{q_i}{q} + p \\ &\quad + (\eta_i - 1)\left(\frac{1}{b} p\left(1+\sigma^i\right)\frac{q_i}{q} - \frac{c}{b} p\left(1+\sigma^i\right)\frac{q_i}{q} + p\right) \\ &= w_i + \frac{v_i}{L_i Z_i} + \Delta d_i \end{aligned} \tag{4.12}$$

where σ is the conduct parameter of airlines other than i. A zero conduct parameter corresponds to the *Cournot* competition, while the value of -1 corresponds to the *Bertrand* competition. Value of σ greater than zero represents a collusive behaviour. In this study, for simplicity, we assume none of the route-carrier combinations will collude with each other in the liberalised market, meaning that the conduct parameter will be in the range of [-1, 0].

---

[26] Assume $q = LZf$, where L and Z are the average load factor and available seats in the market. It will cause some bias during the simulation. But, with open skies, in the long run each airline would consider to use similar aircraft size to compete each other which will converge to the average.

From Equation (4.12), the equilibrium demand for route-carrier i's can be rewritten as:

$$\hat{q}_i = \frac{b\left(w_i + \frac{v_i}{L_i Z_i} - (\eta_i \hat{p} - \Delta d_i)\right)\hat{q}}{\eta_i (1-c)(1+\sigma^i)\hat{p}}$$
$$\Rightarrow \hat{q}_i = \frac{b\left(w_i + \frac{v_i}{L_i Z_i} - \hat{p}_i\right)\hat{q}}{\eta_i (1-c)(1+\sigma^i)\hat{p}} \tag{4.13}$$

Since all of the past studies estimated frequency elasticity, c, at far less than one, the positivity of route-carrier demand lead to the following condition: i.e., the price charged by route-carrier i should be greater than its per-passenger cost for all surviving route-carriers serving the market.

$$\hat{p}_i > w_i + \frac{v_i}{L_i Z_i} \tag{4.14}$$

Adding first-order conditions in equation (4.12) across J route-carrier combinations in the market yields:

$$\frac{1}{b}\hat{p}(1+\sigma^i) - \frac{c}{b}\hat{p}(1+\sigma^i) + J\hat{p}$$
$$+\sum_{i=1}^{J}\left(\frac{(\eta_i - 1)}{\eta_i}\left(w_i + \frac{v_i}{L_i Z_i} + \Delta d_i\right)\right) = w + \sum_{i=1}^{J}\frac{v_i}{L_i Z_i} \tag{4.15}$$

where $w = \sum_{i=1}^{J} w_i$. Reorganizing Equation (4.15), the equilibrium price and quantity for the OD market can be written as follows:

$$\hat{p} = \frac{b\left(w + \sum \frac{v_i}{L_i Z_i} - \sum_{i=1}^{J}\left(\frac{(\eta_i - 1)}{\eta_i}\left(w_i + \frac{v_i}{L_i Z_i} + \Delta d_i\right)\right)\right)}{(1-c)(1+\sigma^i) + bJ}$$
$$\hat{q} = a^{\frac{1}{1-c}}\hat{p}^{\frac{b}{1-c}}\left(\frac{1}{LZ}\right)^{\frac{c}{1-c}} \tag{4.16}$$

Adopting the method used by Schipper, Rietveld, and Nijkamp (2002), the change in consumer surplus caused by the change in equilibrium price and frequency can be calculated as follows:

$$\begin{aligned}\Delta CS &= \int_{p^{reg}}^{\infty} q\left(p, f^{reg}\right) dp - \int_{p^{lib}}^{\infty} q\left(p, f^{lib}\right) dp \\ &= a\frac{(f)^{c}(p)^{b+1} - \left(\hat{f}\right)^{c}(\hat{p})^{b+1}}{b+1}\end{aligned} \qquad (4.17)$$

In this section, we formulated the computational model and procedures with which we can compute the price, frequency and equilibrium quantities for each of the route-carrier combinations serving a particular OD pair market with and without a bilateral ASA liberalization. In addition, this model allows us to compute the market equilibrium price and traffic volume with and without a bilateral ASA liberalization.

Chapter 5. Data and Assumptions

In order to estimate the effects of air services liberalization, we need to assess the base case situation under the current bilaterals. We chose 2006 data as our base case to run the simulations. This chapter describes the data required for the model estimation and the basic assumptions underlying our simulation model.

5.1. Data

5.1.1. Demand Function

Airfare, traffic and capacity data are required to estimate demand function. Carrier and route specific traffic volume, frequency, load factor, seats and capacity were obtained from the ICAO Flight Stage database, while the airfare data were compiled from Expedia, the well known online travel agency that provides discount airfares.

5.1.1.1 Canada–China Origin – Destination Traffic/Capacity Data

In 2006, there were three airlines, Air Canada, Air China, and China Eastern, serving the Canada–China market. Air Canada is the only Canadian carrier that operates Canada–China routes. Regulated by the Civil Aviation Administration of China (CAAC), Air China controls the Canada–Beijing market while China Eastern serves the Canada–Shanghai market.

Table 5.1[27] presents the traffic and capacity data for each carrier that operated in the Canada–China market during 2006. On the Vancouver–Beijing route, 46% of the air passengers were carried by Air Canada, even though it offered more than 50% of the flights on this route. Air Canada represented over 50% of the market share on the Vancouver–Shanghai route in terms of both traffic volume and capacity. In addition, Air Canada was the only carrier on the Toronto–Beijing route in 2006 (Figure 5.1). In total, Air Canada had a 59% of the traffic volume dominating the Canada–China market. However, as shown in the Figure 5.2, we observed that the number of passengers carried by Air Canada had been decreasing over

[27] Due to the fact that the non-stop service on the Toronto – Shanghai route was not operated until June 16, 2006, it will be omitted in this study.

years. For example, Air Canada's market share on the Vancouver–Shanghai route decreased from almost 80% in 2004 to only 47% in 2006.

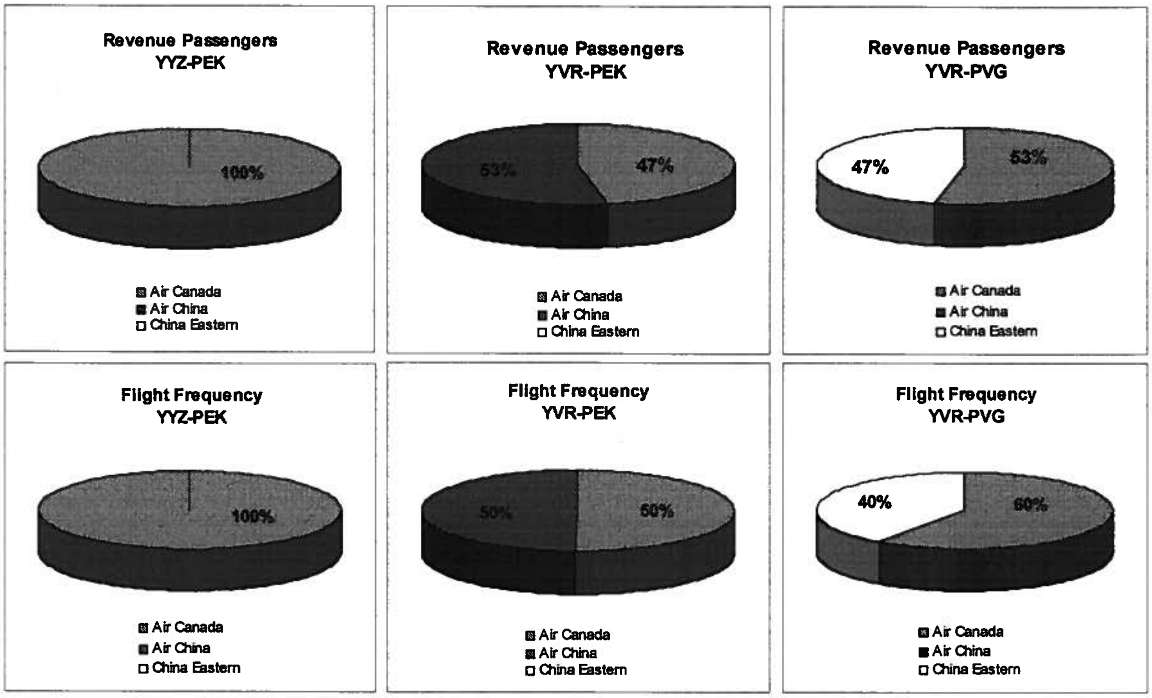
Table 5.1 Canada–China Traffic and Capacity Data, 2006

		Air Canada	Air China	China Eastern	Total
Revenue Passengers	YYZ – PEK	105,230			105,230
	YVR – PEK	118,593	134,499		253,092
	YVR – PVG	119,526		104,529	224,055
Flight Frequency	YYZ – PEK	465			244
	YVR – PEK	719	708		1,469
	YVR – PVG	723		485	1,208
Capacity	YYZ – PEK	132,116			132,116
	YVR – PEK	151,008	157,205		308,213
	YVR – PVG	146,360		144,587	290,947
Available Seats	YYZ – PEK	284			284
	YVR – PEK	210	222		432
	YVR – PVG	202		298	500
Load Factor	YYZ – PEK	79.6%			79.6%*
	YVR – PEK	78.5%	85.6%		82.1%*
	YVR – PVG	81.7%		72.3%	77.0%*

Source: Compiled from ICAO Traffic by Flight Stage Database

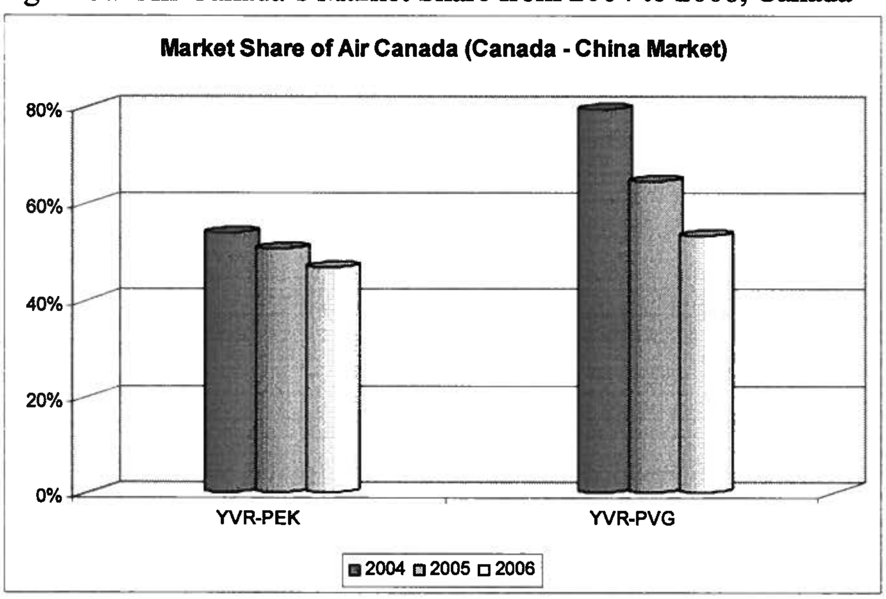
*: Average of the load factor for a particular route

Figure 5.1 Market Share by Carriers in the Canada – China Market, 2006



Source: Compiled from ICAO Traffic by Flight Stage Database

Figure 5.2 Air Canada's Market Share from 2004 to 2006, Canada – China Market



Source: Compiled from ICAO Traffic by Flight Stage Database

As discussed in Chapter 2, the air passengers volume in the Canada–China market have been consistently increasing over the years, from 400,000 in 2004 to 600,000 in 2006. One of the main reasons for such traffic increase was that the flight frequencies between these two countries were increased (shown in Table 5.2). However, frequency increase could not keep up with the increase in demand, as reflected by the increase in the average load factor. This implies that potential passengers may have been blocked out of the direct flight market due to the capacity regulation. Many of them were forced to route via a third country.

Table 5.2 Capacity Changes for Each Route (2004 – 2006)

		2004	**2005**	**2006**
Flight Frequency	YYZ – PEK	-	244	465
	YVR – PEK	1,372	1,389	1,427
	YVR – PVG	894	1,083	1,208
	Total	2,266	2,716	3,100
Average Load Factor	YYZ – PEK	-	80.5%	79.6%
	YVR – PEK	81.7%	81.9%	82.0%
	YVR – PVG	68.0%	71.2%	77.0%
	Average	74.9%	77.9%	80.0%

Source: Complied from ICAO Traffic by Flight Stage Database

Air passengers are generally classified to two broad groups: leisure passengers and business passengers. Leisure passengers and business passengers have different demand elasticities and frequency elasticities, consequently their responses to the air liberalization may be different. For example, more leisure passengers may be attracted by the lower airfare while potential business travellers may be attracted by the higher frequency. However, due to the data limitation, this study is not able to distinguish the reactions between leisure and business passengers.

5.1.1.2 Airfares for Canada–China Market

Market average airfare is used in the model. In order to measure the market average airfare, we have to retrieve the airfares for each of the route-carrier combinations. For example, for the YVR–PEK route, we have to obtain airfares for 5 route-carrier combinations:

- YVR – PEK, Air Canada non-stop services
- YVR – PEK, Air China non-stop services
- YVR – ICN – PEK, Korean Air one-stop services
- YVR – NRT – PEK, Japan Airlines one-stop services
- YVR – HKG – PEK, Cathay Pacific one-stop services

With the airfares for each route-carrier combination, market average airfare can be calculated by taking the arithmetic mean of the above 5 route-carrier combinations.

As we all know, airfares vary greatly between the peak season and the off-peak season. In order to account for the seasonality of the airfare we collect and compute three sets of the average airfare for each route-carrier combination: April (shoulder season), July (peak season), and November (off-peak season).

Note that the one-stop airfares retrieved from Expedia may be overvalued because the air services between Canada and Japan, Korea and Hong Kong were restrictive and the capacity for these routes may not be enough to show the real price for the one-stop route-carrier combinations. Hence, using the observed one-stop airfares without any adjustment would have caused biases in the simulations. Since it is difficult to reflect the real price for the one-stop airfares, we use a different approach to calculate the market average airfare (shown in equation 4.6). The logic is that the travel time is different between direct flight and one-stop flight. Passengers are willing to pay more for the direct flight as it save the travel time. Therefore, given the average airfare for a non-stop route and the WTP for the travel time, we can calculate the average market airfare for a particular simulated OD market.

It should be noted that only taking into account of the WTP of the travel time is insufficient because passengers prefer to choose an airline with better services and are often willing to pay more for services such as service efficiency, language fluency, airport services, etc. Therefore, by introducing quality index, the equation 4.6 also captures the character that an airline can charge an airfare other than other carriers in a particular route according to the quality of the service they provide. Defined in the methodology section, an airline's quality index is the airline's quality rate divided by the average quality rate of the airlines in the market, in which the airline's quality rate can be retrieved from SKYTRAX[28].

Noted that we collect the lowest prices from Expedia always provides the lowest price. We believe the average yield airline receives would be higher than the lowest Expedia fares Therefore, all these fares were adjusted upward by 15%. Table 5.3 presents the average airfare used in our simulation.

Table 5.3 One Way Average Market Airfares for Each Route-Carrier Combination, 2008

	Air Canada	**Air China**	**China Eastern**	**Market average airfare**
YYZ – PEK ($)	1,136			1,024
YVR – PEK ($)	805	678		727
YVR – PVG ($)	727		601	665

Ideally, we should have collected the 2006 airfare data in order to be consistent with the traffic data. However, the 2006 airfare for Canada – China market is unavailable. Therefore, the average spot airfare was used in this study.

5.1.2. Cost Function

As described in Chapter 4, the cost function includes two terms, the passenger operating cost and the flight operating cost. In order to obtain the data of unit cost per passenger (per-passenger operating cost) and unit cost per flight (per-flight operating cost), one must identify the total segment operating cost (the cost for a particular route) for each airline first. Unfortunately, such information is confidential. One way to estimate the segment operating cost is to multiply the total operating cost by the proportion of the ASK (Available Seat Kilometers) on a specified route in the total ASK for a given airline. In order to do this, the first step is to measure the value of the CASK (Cost per Available Seat Kilometers).

[28] SKYTRAX presents an online summary of the actual quality ranking of airlines around the world.

5.1.2.1 The Value of the CASK

An airline's CASK depends greatly on average stage length as well as other factors such as percentage of non-passenger business, percentage of leased aircraft, and etc. Using the CASK directly without any adjustment may be misleading. Therefore, we need to adjust CASK by average stage length.

Brander and Zhang (1990) have proposed a method to adjust CASK by introducing θ:

$$C_{a-i} = C_i \left(\frac{D_k}{l_i} \right)^{-\theta}$$

C_i = i th airline's actual CASK
C_{a-i} = i th airline's adjusted CASK
D_k = the distance of route k
l_i = stage length of airline i

It is well known that airline costs are strictly concave in distance rather than linear, which implies $0 < \theta < 1$. The higher the value of θ, the stronger the tapering effect. Brander and Zhang (1990) used θ = 0.5 for the base case analysis of the U.S. domestic market. However, considering the international overseas market, there is not a strong tapering effect. Thus, this study adjusts θ to a lower value, say θ = 0.2. The adjusted CASK will be:

Table 5.4 Carriers CASK, 2006[29]

	Total Operating Cost (US$ million)	ASK (million)	Average Stage Length (km)	CASK (US cents)	Adj. CASK (US cents)
Air Canada	6,430	98,283	1,405	6.542	4.366*
Air China	4,141	83,492	1,727	4.960	3.606
China Eastern	3,775	70,468	1,435	5.358	3.709

Source: Compiled from Airlines' Annual Report 2006 & ICAO Financial Database

[29] Note that the adjusted CASK for the indirect route-carrier combinations would vary depending on which routes they serve. Due to the limit of space, this information will be presented in the appendix.

*: Air Canada serves YYZ – PEK, YVR – PEK and YVR – PVG routes. Thus, Air Canada has different adjusted CASK for each route. The adjusted CASK in the above table uses YYZ – PEK as an example.

With the adjusted total operating cost for each route-carrier combination, the ASK for the specified route and the total ASK for each carrier, one can calculate the estimated segment operating cost for each route-carrier combination as shown in Table 5.5:

Table 5.5 The Segment Operating Cost for Each Airline on Each Direct Route, 2006

	Adj. Total Operating Cost (US$ million)	ASK for Routes (million)	Total ASK (million)	Segment Operating Cost (US$ million)
Toronto – Beijing Route				
Air Canada	4,291	1,402	98,283	61
Vancouver – Beijing Route				
Air Canada	4,485	1,284	98,283	59
Air China	3,011	1,337	83,492	48
Vancouver – Shanghai Route				
Air Canada	4,432	1,318	98,283	59
China Eastern	2,614	1,304	70,468	48

5.1.2.2 Per-Flight Operating Costs and Per-Passenger Operating Costs

As mentioned earlier, the block hour measure is used to compute the flight operating costs. For the U.S. airlines, the aircraft specific block-hour operating costs are available from the Bureau of Transport Statistics (FORM 41 data). Unfortunately, this study involves Canadian and Chinese carriers where the block hour data is unavailable. To solve this problem, we take American Airlines (AA) as the base airline, and adjust AA's block hour costs with its relative cost competitiveness to the Canadian and Chinese carriers to estimate the block hour cost of Canadian and Chinese carriers. As explained by Gillen, Harris and Oum (2002), "this involves taking account of the differential total factor productivity (TFP) and the aggregate input price index between the AA and the carriers under our consideration". Oum and Yu

(2001) did an extensive cost competitiveness study. Their competitiveness estimates were used for the adjustment.

Table 5.6 compares the block hour costs for AA with different aircraft types. After adjusting the block hour costs by the cost competitiveness, the per-flight operating costs were calculated (flying hours times the AA block hour cost adjusted by the cost competitiveness). As FORM 41 does not have data for the aircraft A340, the direct competitor/equivalent Boeing 777's block hour costs were used as a proxy.

It should be noted that the cost competitiveness used in this study were estimated in 2001 and thus out of date. Updated estimates should be used. However, a new cost model must be estimated to update the cost competitiveness indicators, which will be major efforts with an extensive data requirement, and beyond the scope of this thesis.

Table 5.6 Per-Flight/Per-Pax Operating Costs for Each Route-Carrier Combination, 2006

	Flying Hours	**Aircraft Type**	**Block-hr Costs (AA) (US$)**	**Cost Competitiveness**	**Per-Flight Operating Costs (US$)**	**Per-Pax Operating Costs (US$)**
Toronto – Beijing Route						
Air Canada	13.17	777	7,908	8.5%	112,970	82
Vancouver – Beijing Route						
Air Canada	11.5	767-300	6,136	8.5%	76,558	30
Air China	11.5	767-300	6,136	-9.3%	63,999	22
Vancouver – Shanghai Route						
Air Canada	12.08	767-300	6,136	8.5%	80,442	11
China Eastern	12.08	A340	7,123	-9.3%	86,666	60

It should be noted that, as indicated in Table 5.6, Air Canada had the highest per-passenger operating cost on the YYZ – PEK route because it only operated 4 flights per week on this route and was not able to carry enough passengers to lower the per-passenger operating cost. This means Air Canada had to pay more in order to serve this route. Similarly, on the YVR – PVG route, since Air Canada served 7 flights per week while China Eastern served 4 times per week, Air Canada could carry more passengers. As a result, Air Canada took advantage of the economy of scale or economy of density, and was able to save the per-passenger operating cost.

5.2. Assumptions

We have to make a number of assumptions about the parameters used in the model as they are "borrowed" from previous studies.

5.2.1. Price Elasticity and Frequency Elasticity

Considering China is a developing country whose residents are more sensitive to price than other countries, it is reasonable to assume the price elasticity at -1.2 and a lower frequency elasticity (0.15) for the Canada–China market. In addition, sensitivity tests were conducted within the range of [-1.0, -2.0] and [0.1, 0.6] for price elasticity and frequency elasticity, respectively.

5.2.2. Conduct Parameter

The conduct parameter measures how aggressive airlines are. Fu, Lijesen and Oum (2006) state that "the larger the negative conduct parameter, the more aggressive the firm's competition strategy".

The simulations start from the point where the conduct parameter is equal to zero if airlines under examination on a particular route are members of one alliance. Otherwise, the conduct parameter is assumed to be -0.2. This assumption can be justified as alliance members normally do not compete with each other, whereas the real competition exists among airlines that are not in alliance. And again a sensitivity test will be conducted in order to measure the changes in the price and quantity when the conduct parameter approaches to -1.

5.2.3. Load Factors

Load factors, in this model, should be endogenous. However, due to the system constraints of the model, the equilibrium of the load factor for each airline could not be calculated. Thus, the load factor for the Canada–China market is assumed to be 0.75 when air liberalization is introduced. Nevertheless, this assumption can be relaxed with sensitivity test to measure the effect when the load factor is not 0.75 under a liberalized scenario or an Open Skies scenario. The minimum level of the load factor in the sensitivity test was set at 0.6 assuming it would not be worse than the current case without liberalization (the load factor of China Eastern was 0.72 in 2006), and maximum at 0.95 since it is unrealistic to assume the plane would always be full.

5.2.4. Operating Costs

Previous studies show that air liberalization and deregulation force carriers to improve their productivity and efficiency as they face increased competition. Air liberalization relaxes restriction on capacity and encourages new entrants. To survive the intensive competition, carriers will have to improve their operating costs. Therefore, we assume carriers serving the Canada–China market would reduce their costs by 5% if the air service between these two countries were liberalized.

In summary, we estimate our empirical models and conduct a series of simulations based on the data and assumptions discussed earlier. The following chapter will present and discuss the simulation results.

Chapter 6. Empirical Results

In this chapter, we will measure the effects of liberalizing Canada's restrictive bilateral ASA with China. Two scenarios will be analyzed:

- Case I: deregulation of the price and seat capacity (frequency and aircraft size),
- Case II: deregulation of all restrictions on price, seat capacity and entry.

The aggregate seat capacity that carriers can offer is usually restricted by bilateral agreements. Although this type of agreement allows trade-off between frequency of service and aircraft size, for most bilateral routes the cost characteristics and the need to offer near daily flights limit the choice down to one or two aircraft types. Therefore, for convenience of analysis, our model will incorporate frequency competition only.

In section 6.1, we present the expected results of the liberalization cases I and II. Section 6.2 presents the design and results of sensitivity tests on the parameter values only for the Case II. The summary results are provided in section 6.3

6.1. Expected Economic Effects of Bilateral Air Services Liberalization

In this section, we discuss the expected results of Case I deregulation (price and frequency deregulation) and Case II deregulation (open skies – deregulation of $3^{rd}/4^{th}$ freedom traffic and entry) for each of the Canada-China bilateral routes.

6.1.1. Expected Results under Case I Deregulation: Price and Flight Frequency

In this sub-section, the computational results for the Case I deregulation are reported and compared to the Base Case (2006 calendar year situation).

YVR – PEK (Vancouver – Beijing) Route

Since both of the current bilateral carriers serving this market (Air Canada and Air China) are Star Alliance partners and have just started their codeshare flight operations, there is a risk that these two carriers may not compete vigorously in this market. Therefore, we decide to set their conduct parameter at zero signifying *Cournot* competition in this duopoly market[30].

Our computational results based on the model presented in Chapter 4 are reported in Table 6.1. The key expected results of Case I deregulation in this market are:

- average airfare on the direct YVR-PEK travel would fall by 16.7%;
- total passenger volume to increase by 22.4%, from 253,092 (Base Case 2006 actual volume) to 309,699 passengers, and
- combined frequency of the two carriers to increase by 33.8%.

Table 6.1 Expected Results: Case I (Deregulating Airfare and Frequency), YVR-PEK

YVR - PEK	Air Canada Base Case	Air Canada Expected Outcome (Δ)	Air China Base Case	Air China Expected Outcome (Δ)	Total/Average Base Case	Total/Average Expected Outcome (Δ)
Airfare (US$)	1,610	1,353 (-16.0%)	1,357	1,119 (-17.5%)	1,484	1,236 (-16.7%)
Passenger	118,593	143,464 (21.0%)	134,499	166,235 (23.6%)	253,092	309,699 (22.4%)
Frequency	719	911 (26.7%)	708	998 (41.0%)	1,427	1,909 (33.8%)
ΔProfit (US$ '000)	-	-13,099	-	-16,489	-	-29,588
ΔCS (US$ '000)	-	-	-	-	-	62,827
ΔTotal Welfare (US$ '000)	-	-	-	-	-	33,228

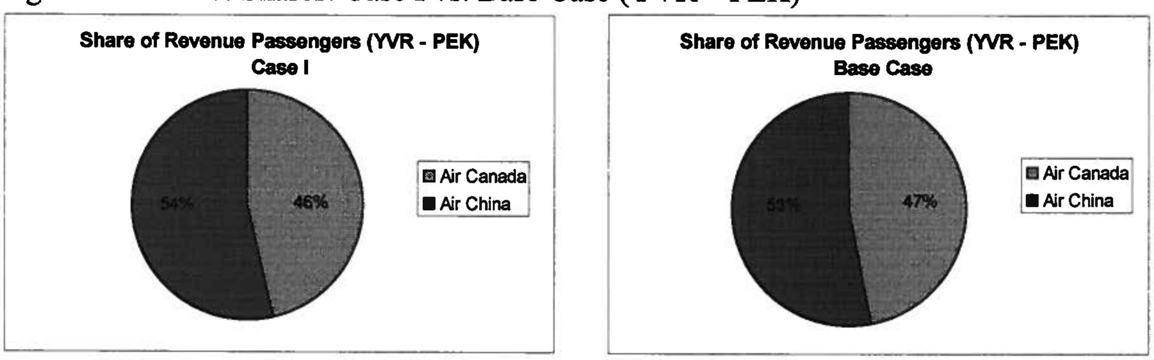
Note: In obtaining the above computational results, conduct parameter was set at 0 (*Cournot* competition)

[30] Since Air China began their codesharing flight operations with Air Canada only from 2008, and our study is based on year 2006 data, the nature of competition in YVR-PEK route in 2006 may be better characterized by *Cournot* competition than collusion.

The results in Table 6.1 indicate further that under Case I deregulation, Air Canada would not lose passengers despite that they charge a higher average fare than the airfare Air China would charge. The reason for this appears to be that Air Canada is able to provide better services for which passengers are willing to pay more. On the other hand, Air China would attract more passengers by offering more flight frequencies taking advantage of their lower unit cost of flight operation. As a result, as both carriers take advantage of their respective strengths, the equilibrium market shares of the two carriers under Case I deregulation would remain essentially the same as the Base Case as shown in Figure 6.1.

Consumers would benefit under Case I deregulation as indicated by the US$63million increase in the consumer surplus in the market per year. On average, the consumer surplus increases by US$203 per passenger. The aggregate economic welfare (sum of producers' and consumer surpluses) would increase by about US$30 million per year in this market[31].

Figure 6.1 Market Shares: Case I vs. Base Case (YVR – PEK)



<u>YVR – PVG (Vancouver – Shanghai) Route</u>

Once price and seat capacity restrictions are removed (without allowing new entry), the incumbent carriers are expected to increase flight frequency on this route. The increased seat capacity would lead to lower airfares. Consequently, total passenger traffic volume on this direct route would increase. The increase in traffic would consist of two components: passengers stimulated by lower airfares, and passengers switching from one-stop routes (via

---

[31] We can not regard all 100% of Air Canada's producer surplus belong to Canada because Air Canada's shareholders are widely distributed via Toronto Stock Exchange. However, since it is difficult to retrieve the information on composition of the carriers' ownerships, we are not able to allocate the total carriers' losses to various foreign and domestic shareholder groups.

Korea, Hong Kong, or Japan points) to the direct route due to the lower airfares and improved frequencies.

Table 6.2 presents the expected market outcomes on this route, which would prevail under Case I. The key results are:

- the average non-stop airfare would decrease by 6.2%;
- the total passenger traffic volume would increase by 29.7%, from 224,055 (2006) to 290,541 passengers; and
- the combined frequencies of Air Canada and China Eastern increase by 34%.

Table 6.2 Expected Results: Case I (Deregulating Airfare and Frequency), YVR-PVG

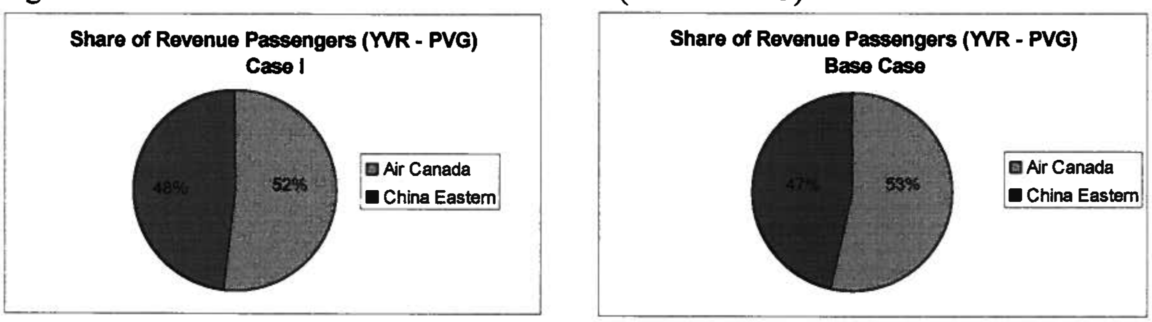
YVR - PVG	Air Canada Base Case	Air Canada Expected Outcome (Δ)	China Eastern Base Case	China Eastern Expected Outcome (Δ)	Total/Average Base Case	Total/Average Expected Outcome (Δ)
Airfare (US$)	1,454	1,385 (-4.8%)	1,202	1,106 (-8.0%)	1,328	1,245 (-6.2%)
Passenger	119,526	149,918 (25.4%)	104,529	140,624 (34.5%)	224,055	290,541 (29.7%)
Frequency	723	990 (36.9%)	485	629 (29.7%)	1,208	1,619 (34.0%)
ΔProfit (US$ '000)	-	-2,758	-	1,683	-	-1,705
ΔCS (US$ '000)	-	-	-	-	-	35,400
ΔTotal Welfare (US$ '000)	-	-	-	-	-	33,695

Note: In obtaining the above computational results, conduct parameter was set at -0.2

With its better service quality, Air Canada would be able to charge a higher airfare than China Eastern, who has cost advantage but is not strong enough to make up the disadvantage of the poor service quality. Therefore, Air Canada would still be able to lead the market even while charging a higher airfare. The market share of the two carriers serving the market under the Case I will be presented in Figure 6.2.

Along with the increasing competition, the carriers' profit would decrease. As shown in Table 6.2, the decrease of carriers' profit would be above US$1 million per year. However, the reduction of the airfare and the increase of the frequency would increase consumer surplus by over US$35 million per year. Overall, the aggregate economic welfare would increase by about US$30 million per year. Given the expected passenger volume on this route, the additional consumer surplus per passenger would be US$122 per year under Case II.

Figure 6.2 Market Shares: Case I vs. Base Case (YVR – PVG)



Note that Air Canada was the only carrier that served the Toronto – Beijing route in 2006. With the entry restriction, Air Canada would continue to enjoy monopoly power without having to change its strategy. Hence, the simulation does not include the Toronto – Beijing route under Case I (deregulation of price and flight capacity only).

6.1.2. Expected Results under Case II Deregulation: Price, Flight Capacity and Entry

In case II, new carriers are allowed to enter the markets. For examples, in the long term, Westjet from Canadian side and Shanghai Airlines from China side may enter the Vancouver–Shanghai route, and Air China may enter the Toronto–Beijing route. Considering there are only a limited number of international airlines existing in both countries, we decided to analyze the case where only one new carrier is assumed to enter the market. Since the new entrant carrier by definition has never served the route, it is difficult to predict their operating costs for the route. Therefore, we have to assume that new entrants will enter the market with the same operating cost as Air Canada.

The empirical results for Case II deregulation are presented below for each of the Canada-China routes.

<u>YVR – PEK (Vancouver – Beijing) Route</u>

The competition would become intensive under Case II (deregulation of price, flight capacity and entry), which implies that the airfares are expected to further decrease. The key results for this route shown in Table 6.3 are presented as follows:

- the average round-trip airfare would fall to US$1,160, from US$1,483, by 21.8%;
- the passenger volume would increase by 42.6%, from 253,092 to 360,955 passengers;
- the total flight frequency would increase by 56.9%.

Table 6.3 Expected Results: Case II (Deregulating Airfare, Freq. and Entry), YVR–PEK

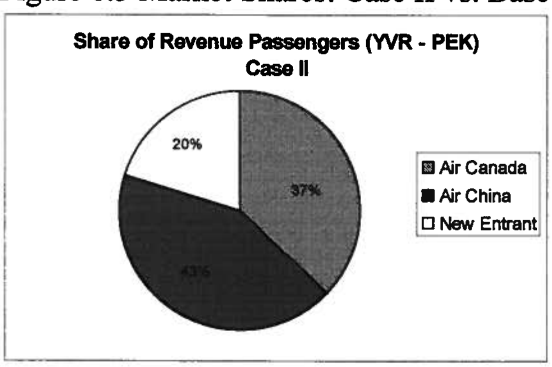
YVR - PEK	Air Canada		Air China		New Entrant	Total/Average	
	Base Case	Expected Outcome (Δ)	Base Case	Expected Outcome (Δ)		Base Case	Expected Outcome (Δ)
Airfare (US$)	1,610	1,291 (-19.8%)	1,357	1,063 (-21.7%)	1,128	1,483	1,160 (-21.8%)
Passenger	118,593	133,011 (12.2%)	134,499	154,911 (15.2%)	73,033	253,092	360,955 (42.6%)
Frequency	719	845 (17.5%)	708	930 (31.4%)	464	1,469	2,239 (56.9%)
ΔProfit (US$ '000)	-	-19,172	-	-22,848	5,366	-	-36,654
ΔCS (US$ '000)	-	-	-	-	-	-	84,058
ΔTotal Welfare (US$ '000)	-	-	-	-	-	-	47,404

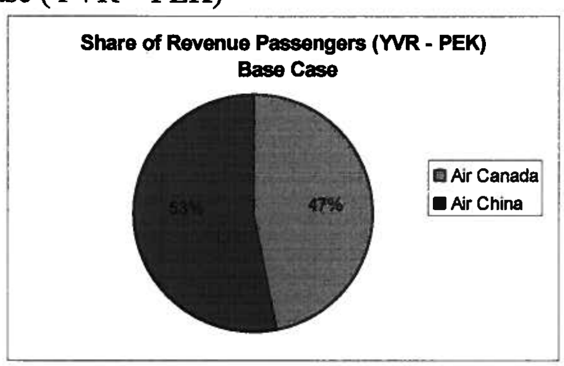
Note: Assume conduct parameter to be 0.

It is interesting to note that the new entrant would not cause a distraction of passenger volume from the incumbent airlines under Case II (deregulation of price, flight capacity and entry). The traffic volume for Air Canada and Air China would increase by 12.2% and 15.2%, respectively. The flight frequency would also increase by 17.5%, from 719 to 845, for Air Canada, and by 31.4%, from 708 to 930, for Air China. Nonetheless, it is expected that the new entrant would take a portion of the market share. As shown in Figure 6.3, Air China would retain its leading position by taking 43% of the market, followed by Air Canada and the new entry at 37% and 20%, respectively.

As reported in Table 6.3, although the overall decrease in carriers' profits on the this route would be over US$35 million per year, consumer surplus would significantly increase by about US$84 million per year due to the reduction of the airfare and increase of the flight frequency. On average, the increase in consumer surplus would be US$233 per year per passengers. It is important to understand that not only the carrier's profit but also consumer surplus should be considered when evaluating policies. Under Case II deregulation, the aggregate economic welfare gains (sum of producer surpluses and consumer surplus) would be above US$45 million per year.

Figure 6.3 Market Shares: Case II vs. Base Case (YVR – PEK)





<u>YVR – PVG (Vancouver – Shanghai) Route</u>

The intensive competition under Case II deregulation on this market would further force the airfare to decline (see Table 6.4). The key expected outcomes for this market are:

- the decrease in the average non-stop airfare would be 19%;
- the passenger volume would increase by 41.7%, from 224,055 (Base Case) to 371,433 passengers; and
- the combined flight frequency would increase by 50.1%.

Table 6.4 Expected Results: Case II (Deregulating Airfare, Freq. and Entry), YVR – PVG

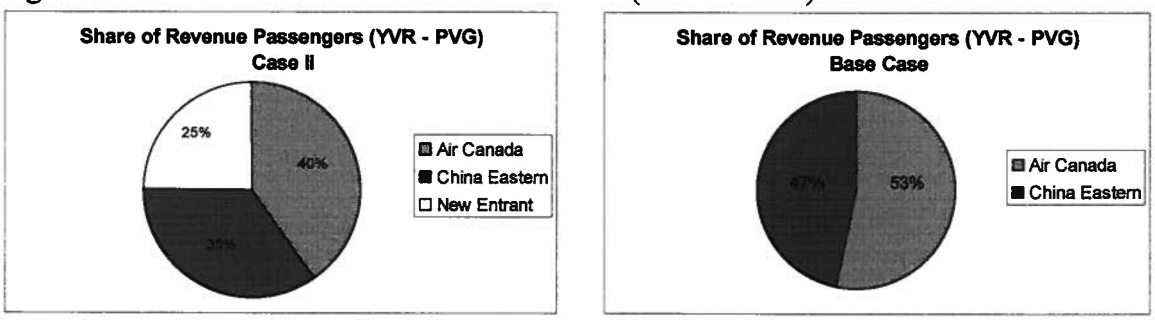
YVR - PVG	Air Canada		China Eastern		New	Total/Average	
	Base Case	Expected Outcome (Δ)	Base Case	Expected Outcome (Δ)	Entrant	Base Case	Expected Outcome (Δ)
Airfare (US$)	1,454	1,231 (-15.3%)	1,202	979 (-18.6%)	1,018	1,328	1,076 (-19.0%)
Passenger	119,526	127,751 (6.9%)	104,529	110,285 (5.5%)	79,397	224,055	371,433 (41.7%)
Frequency	723	843 (16.6%)	485	493 (1.7%)	477	1,208	1,814 (50.1%)
ΔProfit (US$ '000)	-	-17,097	-	-9,825	5,112	-	-21,810
ΔCS (US$ '000)	-	-	-	-	-	-	61,872
ΔTotal Welfare (US$ '000)	-	-	-	-	-	-	40,062

Note: Assume conduct parameter to be -0.2.

The traffic volume for incumbent carriers – Air Canada and China Eastern – would increase by 6.9% and 5.5%, respectively, even under case II in which new entrants are free to enter (see Table 6.4). Despite of the increase in the passenger volume for both incumbent carriers, the new entrant would be able to take a portion of the market share from them. In this particular route, the new entrant would have 25% of the market share under Case II deregulation (Figure 6.4). Air Canada would retain its leading position, but at the level of 40% compared to the base case of 53%.

Similar to Vancouver – Beijing route under Case II, the margin for each carrier would decrease whereas consumer surplus would increase. As shown in Table 6.4, the overall carriers' profit would decrease by US$21 million per year. However, consumer surplus would increase by above US$60 million per year. On average, the increase of consumer surplus per passenger would be US$167 per year. Overall, the aggregate economic welfare gain would be over US$40 million per year.

Figure 6.4 Market Shares: Case II vs. Base Case (YVR – PVG)



YYZ – PEK (Toronto – Beijing) Route

Air Canada was the only carrier serving the YYZ – PEK route with four flights per week (5 flights in peak season) in 2006. Once the entry restriction is removed, Air Canada would no longer be able to enjoy monopoly power as new entrant(s) would enter the market for monopoly margins. The airfare is expected to decrease when moving from monopoly market to duopoly market. The key results shown in Table 6.5 are presented as follows:

- the average non-stop airfare would decrease by 28.4%;
- the passenger volume would increase by 33.1%, from 150,230 to 140,073 passengers; and
- the combined flight frequency would increase by 42.4%.

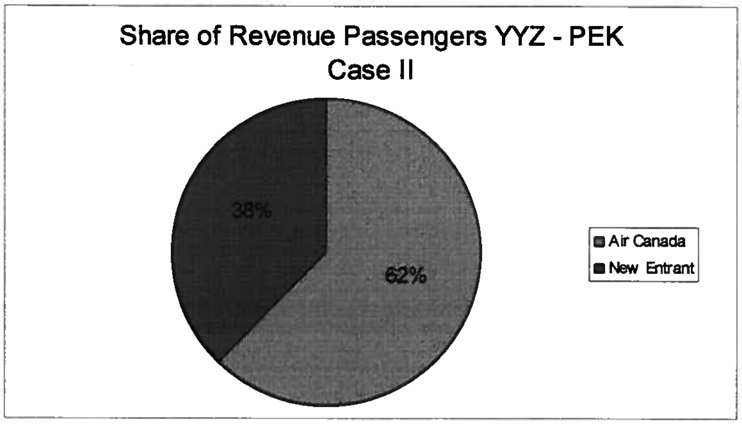
Table 6.5 Expected Results: Case II (Deregulating Airfare, Freq. and Entry), YYZ – PEK

YYZ- PEK	Air Canada		New Entrant	Total/Average	
	Base Case	Expected Outcome (Δ)		Base Case	Expected Outcome (Δ)
Airfare (US$)	2,271	1,786 (-21.4%)	1,469	2,271	1,627 (-28.4%)
Passenger	105,230	87,177 (-17.2%)	52,896	105,230	140,073 (33.1%)
Frequency	465	409 (-12.0%)	248	465	658 (42.4%)
ΔProfit (US$ '000)	-	-34,317	8,060	-	-26,258
ΔCS (US$ '000)	-	-	-	-	48,433
ΔTotal Welfare (US$ '000)	-	-	-	-	22,175

Different from the YVR – PEK and YVR – PVG routes, passengers carried by the incumbent carrier, Air Canada, would decrease by 17.2% from 105,230 to 87,177 passengers under Case II (deregulation of price, seat capacity and entry). As shown in Figure 6.5, the new entrant would take 38% of the market.

Along with diminishing monopoly power, carriers would see a decrease of profit. The overall carriers' profit, as presented in Table 6.5, would decrease by US$26 million per year. However, on the other hand, consumer surplus would increase by almost US$50 million per year. On average, the increase of consumer surplus per passenger would be US$346 per year. The aggregate economic welfare would increase by above US$20 million per year.

Figure 6.5 Market Shares: Case II vs. Base Case, (YVR – PVG)



6.1.3. Summary of the Expected Results

In the above, we presented the expected economic effects of Case I and Case II deregulation of bilateral air services for each of the Canada-China bilateral markets. Overall, the results show that the deregulation leads to the reduction of the average airfares which would attract additional passengers, and thereby induces carriers to increase their flight frequencies.

Table 6.6 presents the aggregate results of all Canada-China routes under two deregulation cases: Case I (deregulation of price and seat capacity only) and case II (deregulation of price, seat capacity and entry).

Consumer surplus would increase by US$98 million per year and US$194 million per year under Case I and Case II, respectively. If we assume that 60% of the passengers are Canadian residents[32], the increase in the consumer surplus to Canada would be over US$100 million under Case II (full deregulation).

With Case I deregulation the total combined surpluses of air carriers would decrease by US$16 million and US$15 million per year for Canadian and Chinese carriers, respectively. With Case II deregulation the total carrier surpluses of Canadian and Chinese carriers would decrease by US$65 and US$20, respectively. As expected, the more the bilateral market gets

[32] Again, it is more useful to know how much of the increased consumer surplus belongs to residents of Canada as opposed to foreigners. However, we are not able to allocate the consumer surplus gains to various nationalities because of the lack of data on composition of travelers on each of these routes.

liberalized, the lesser the carriers' surpluses and the larger the consumers benefits becomes. Since the increase in the consumer surplus usually far outweighs the decrease in carriers' surpluses, the aggregate economic welfare would significantly increase: an increase of US$68 million per year with Case I deregulation, and US$110 million per year with Case II.

Table 6.6 Summary Economic Effects under Two Levels of Liberalization

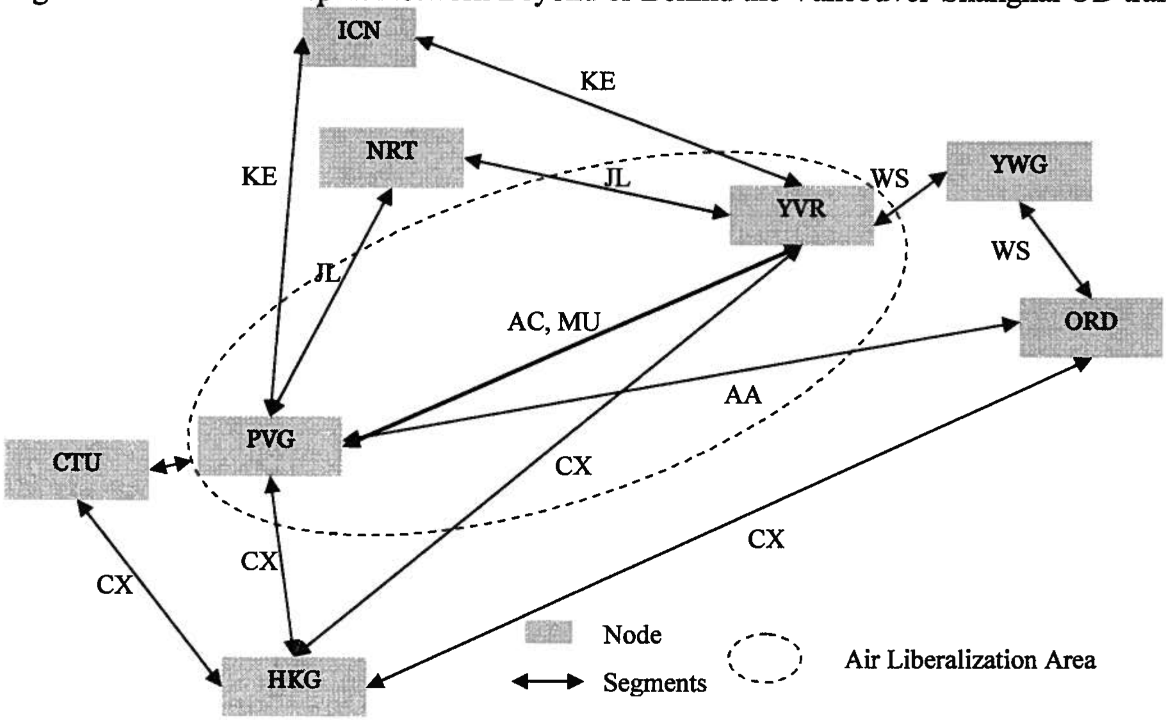
		Case I	Case II
ΔConsumer Surplus (US$ '000)	ΔCS	98,227	194,363
	ΔCS/Pax	0.163	0.240
ΔCarriers Surpluses (US$ '000)	Canadian Airlines	-15,858	-65,221
	Chinese Airlines	-14,805	-19,501
	Total	-30,663	-84,722
ΔAggregate Welfare (US$ '000)		67,564	109,642

Case I: deregulating airfare and seat capacity
Case II: deregulating all including airfare, seat capacity and entry

As mentioned in Chapter 4, we assume the total traffic to be the Origin-Destination traffic. It should be noted that the economic effects presented above are underestimated as this study does not take into account of the possibility of attracting more traffic from behind and/or going beyond the route (OD) markets being deregulated. For example, when deregulation of YVR-PVG market lowers airfares and increase flight frequencies on that route, it is possible to attract more YWG-PVG and YWG-CTU passengers to travel via YVR-PVG against routing their travel via ORD-PVG (see illustration in Figure 6.6[33].

[33] For example, consider there are two passengers originating from Winnipeg, one to Shanghai and the other to Chengdu (China). The passenger to Shanghai could take the flight via Vancouver, via Chicago, or via Chicago and Hong Kong. The passenger to Chengdu could take the flight via Vancouver and Shanghai, via Chicago and Shanghai, or via Chicago and Hong Kong. The price reduction due to the bilateral Canada-China ASA liberalization would induce these two passengers to route their trips via Vancouver. Obviously, this study is not able to measure the liberalization effects on these two passengers and to capture the route substitution effects beyond and behind the Vancouver-Shanghai route. Therefore, our estimates are considered to be the lower bound of the effects of air liberalization.

Figure 6.6 An Air Transport Network Beyond or Behind the Vancouver-Shanghai OD traffic



6.2. Sensitivity Tests

The empirical results reported in the above are based on specific assumed values of airlines' conduct parameters, passenger load factors, elasticities of demand with respect to price and flight frequency, etc. Therefore, it is useful to investigate how sensitive our key results would be if values of these parameters were changed. For simplicity, we limit our sensitivity tests only to case II (deregulation of price, seat capacity and entry).

6.2.1. Sensitivity Test on Firm's Conduct Parameter

The following values of the conduct parameter were used in obtaining the results reported previously:

- 0 for YVR – PEK and YYZ – PEK routes;
- -0.2 for YVR – PVG route

For each of these three routes, we conduct the sensitivity test on the conduct parameter values between 0.0 (*Cournot* Competition) and -1.0 (*Bertrand* Competition) by increment of

-0.2 each time. The range [0.0, -1.0] was chosen because the complete deregulation of price, capacity and entry (Case II) would not lead to a more collusive market situation than under the current bilateral ASA regime. Brander and Zhang (1990, 1993) found that *Cournot* model seems much more consistent with a cross-section data set of Chicago-based duopoly airlines routes involving American Airlines and United Airlines. Previous studies also suggested that airline competitive regime lies between *Cournot* and *Bertrand* games in various markets, but closer to *Cournot* (Oum, Zhang and Zhang, 1993, and Fisher and Kamerschen, 2003).

The graphs in Figure 6.7A describe how average airfares and traffic volumes change for each of the current Canada – China routes as the value of conduct parameter changes from 0.0, to -0.2, -.0.4, -0.6, -0.8 and -1.0. The results indicate a consistent pattern in all Canada-China route markets that average airfare would decrease and the traffic volume to increase when the value of the conduct parameter in our model is lowered.

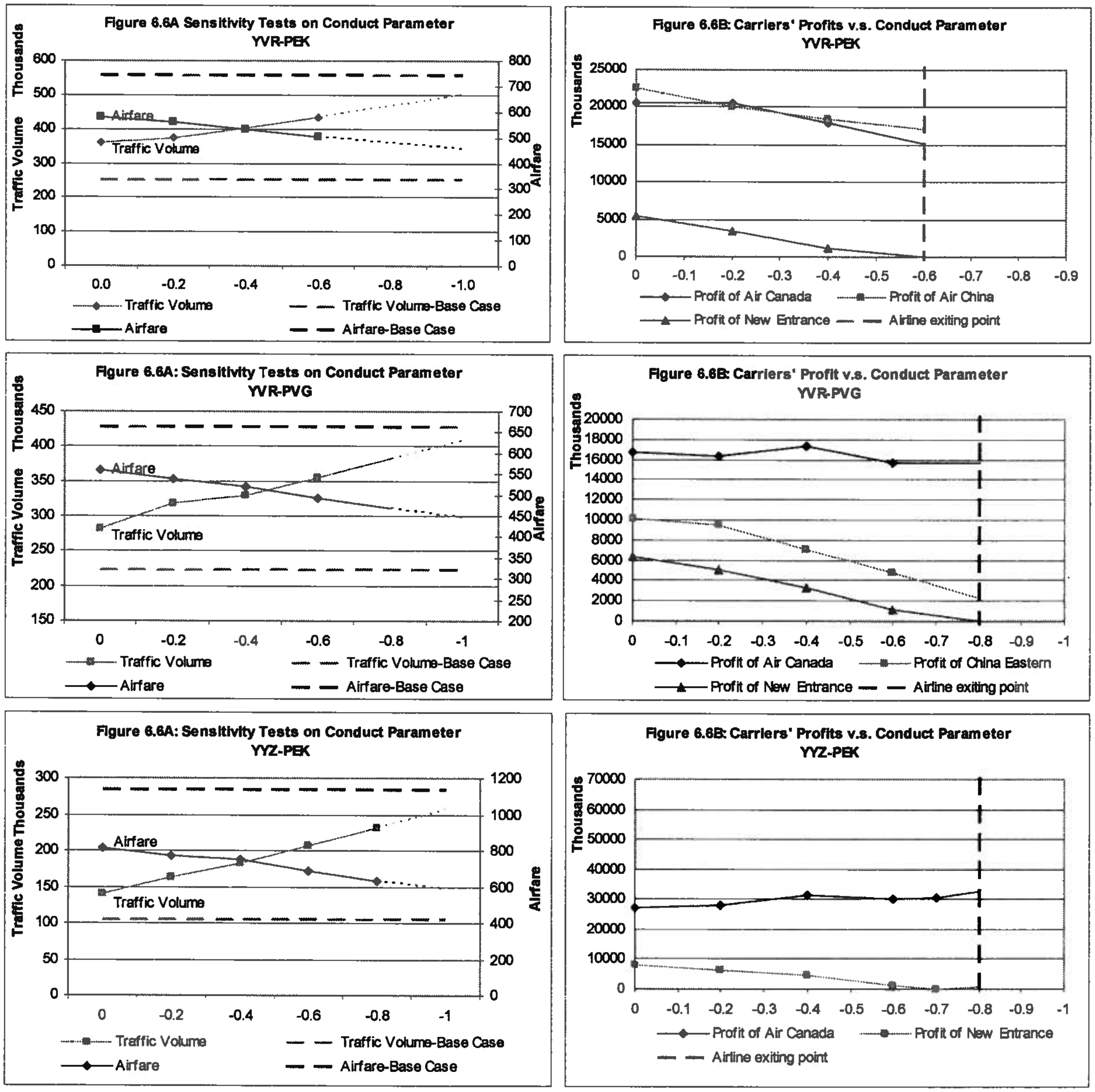
The graphs in Figure 6.7B show how profits of each of the bilateral carriers change on each of the current Canada-China routes as the value of conduct parameter is changed in the same way as in Figure 6.7A. In most of the cases, the profit of each carrier would decrease when the competition becomes intensive[34]. A carrier would be out of the market if it has a negative profit. As shown in the graphs, the carrier would exit when conduct parameter is equal to -0.6 for YVR – PEK route, and -0.8 for YVR – PVG and YYZ – PEK routes. It should be noted that the competition would decrease when a carrier is out of the market, and thereby the remaining carriers would be able to charge a higher airfare. However, other new entrant may be waiting for entry to share the market. Therefore, it is expected that the airfare would decrease again when new carrier(s) re-enter the market.

The graphs in Figure 6.7C present the change in consumer surplus on each of the routes as the value of conduct parameter is changed. For all three routes, consumer surplus would

[34] The carriers' profits reported in this thesis may not be accurate as we use a simplified cost function in the model which only includes two variables. However, the decreasing trend is correct when conduct parameter changes from 0.0, to -0.2, -0.4, -0.6, -0.8 and -1.0.

increase when the conduct parameter is changed from 0.0 to -1.0[35]. In addition, in Figure 6.7D, we present how the aggregate welfare changes on each of the routes as the value of conduct parameter is changed. The graphs show that the change in the aggregate welfare would increase when the competition is more intensive, which implies that the total welfare gain would increase incrementally.

Figure 6.7 Results of Sensitivity Tests on Conduct Parameter



[35] The graphs do not report the values when the values of conduct parameters approach to the exiting point.

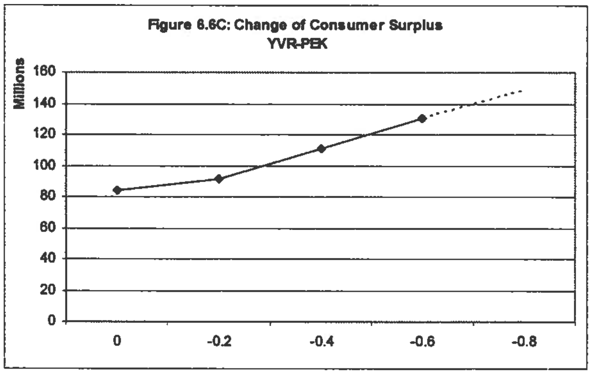


Figure 6.6C: Change of Consumer Surplus
YVR-PEK

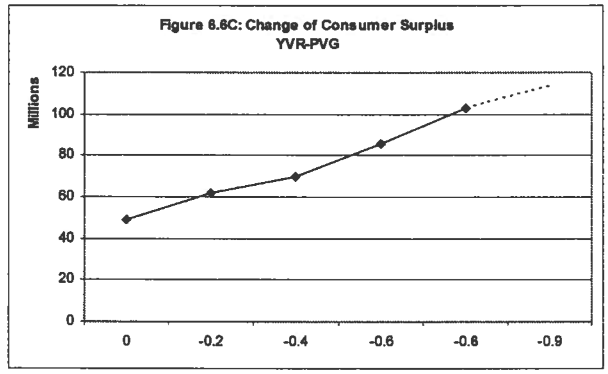


Figure 6.6C: Change of Consumer Surplus
YVR-PVG

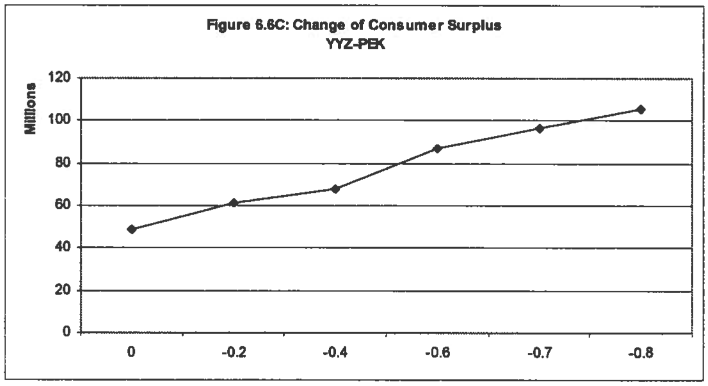


Figure 6.6C: Change of Consumer Surplus
YYZ-PEK

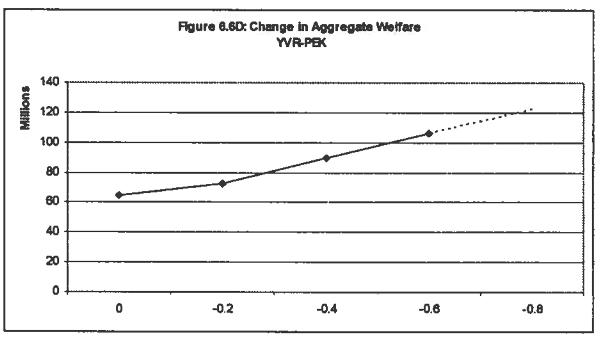


Figure 6.6D: Change in Aggregate Welfare
YVR-PEK

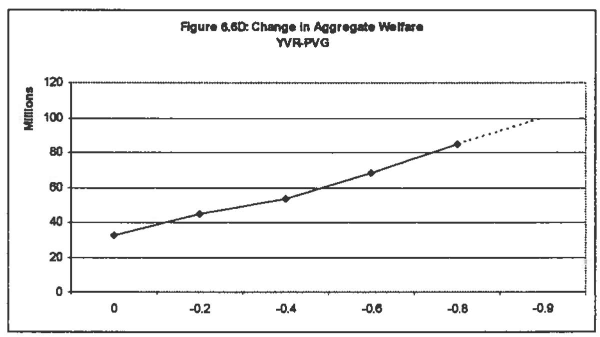


Figure 6.6D: Change in Aggregate Welfare
YVR-PVG

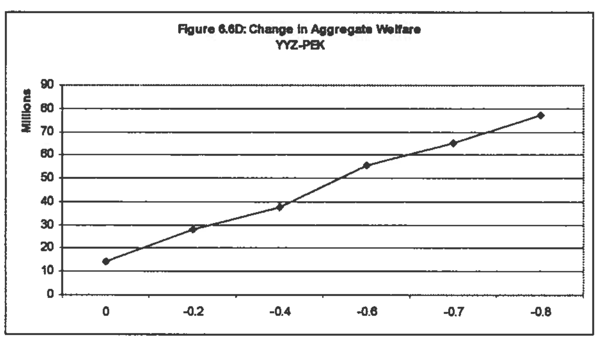


Figure 6.6D: Change in Aggregate Welfare
YYZ-PEK

6.2.2. Sensitivity Test on Load Factor

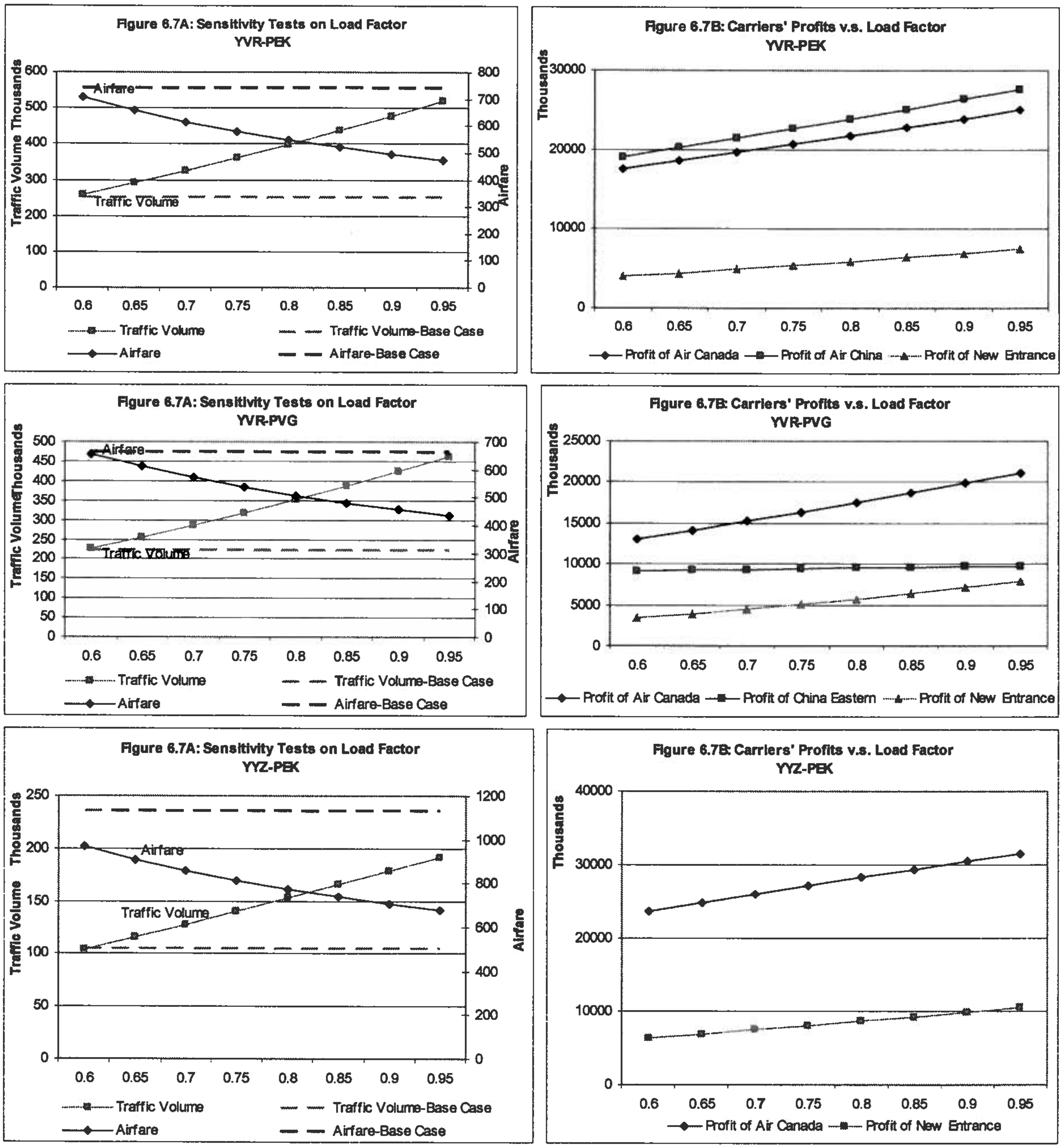
We assume a 75% load factor to estimate the economic effects of bilateral air services liberalization for both deregulation Cases I and II. In order to measure how sensitive the results are with different load factors, we conducted sensitivity tests by increasing the value of the passenger load factor from 60% to 95% with 5% interval.

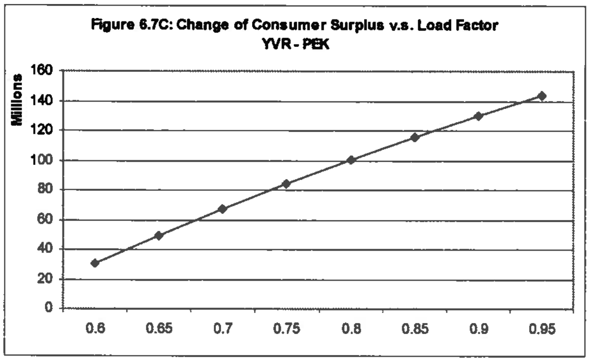
The graphs in Figure 6.8A present how airfare and traffic volume change on each of the routes as the load factor is increased from 60% to 95% with 5% interval. The graphs show that the airfare has a negative relationship while the traffic volume has a positive relationship with the load factor. When the load factor approaches 95%, although more passengers would be carried, the services quality would be compromised because of the crowded airplane, and thus, the airfare would be forced to decrease. It is interesting to note that the situation would not be worse than that of the base case even when the load factor is under the lower bound (60%) for all three routes we estimated.

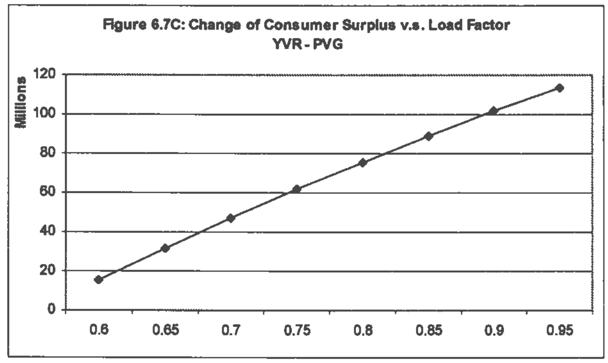
The graphs in Figure 6.8B describe how the carriers' profit changes for each of the routes as the load factor changes from 60% to 95% by increment of 5% each time. Consistently, the carriers' profit is positively related to the load factor for all three routes. Given the passengers to be carried, airlines would be able to arrange fewer flights to accommodate the traffic volume with the increase of the load factor. Therefore, carriers would be able to reduce the operating costs and generate more profits.

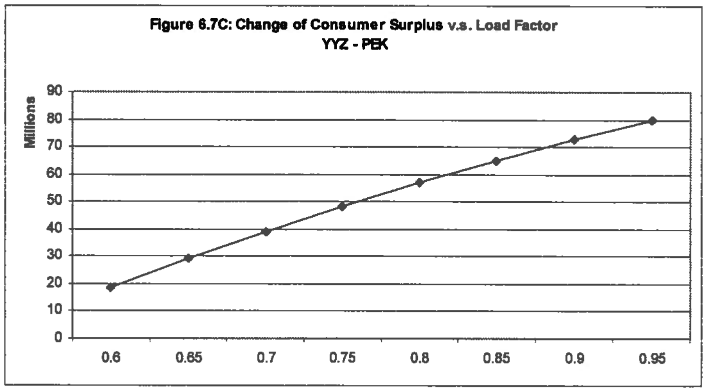
The graphs in Figure 6.8C present how consumer surplus changes for each of the routes as the load factor changes from 60% to 95% by increment of 5% each time. Consumers would benefit from the reduction of the airfare when the load factor increases. As a result, there exists a positive relationship between consumer surplus and the load factor for all three routes.

Figure 6.8 Results of Sensitivity Tests on Load Factor









Note that the above figures capture the character in which only one variable (load factor) is allowed to change. The detailed results will be presented by two-variable tables (conduct parameter and load factor) in the appendix A.3.

6.2.3. Sensitivity Test on Price and Frequency Elasticity

We use the following price elasticity and frequency elasticity in the computable model to estimate the economic effects of air liberalization under two cases:

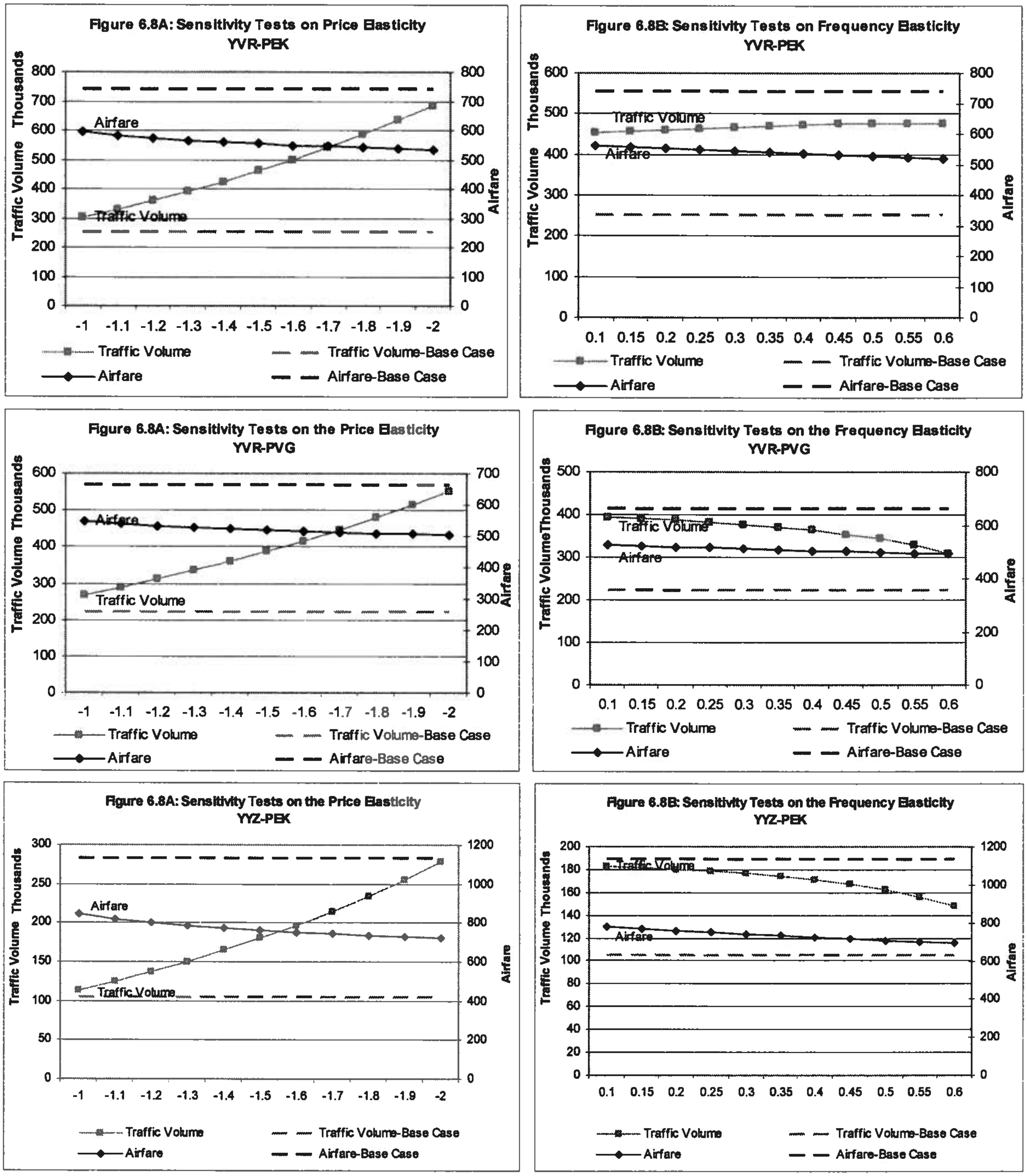
- 1.2 for price elasticity;
- 0.15 for frequency elasticity

This sub-section will present the sensitivity tests on elasticities of demand with respect to price and flight frequency with the range [-1.0, -2.0] and [0.1, 0.6], respectively. The range of price elasticity was chosen considering the majority of the figures fall within [-0.8, -2.0] (Oum, Waters and Yong, 2006), and passengers in Canada – China market should be more sensitive to the price. The reason to choose the above range for frequency elasticity is that the passengers are inelastic to the flight frequency, and many previous studies suggest that the frequency elasticity would be between 0.1 and 0.6.

The graphs in Figure 6.9A capture the results of sensitivity tests on price elasticity in terms of airfare and traffic volume by increment of -0.1 each time from -1.0 to -2.0. For all three Canada – China routes, given the frequency elasticity, the average airfare would continue decreasing if passengers become more sensitive to the price. A reduction of the airfare would attract additional passengers to fly with the direct routes. It should be noted that the results, even under the lower bound of price elasticity (-1.0), would be better than the situation under the base case, which implies that air liberalization would have a positive impact on the market.

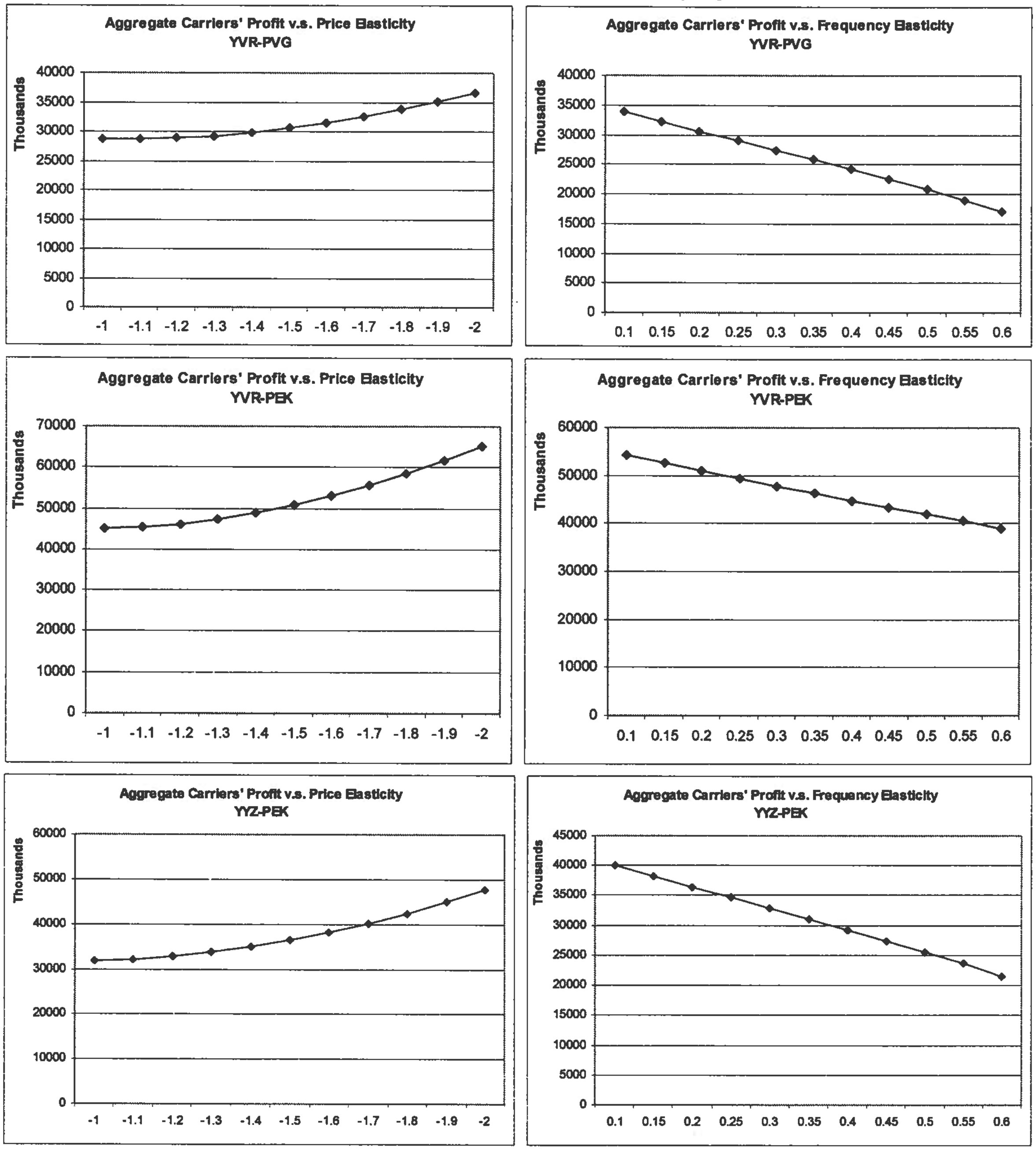
The graphs in Figure 6.9B present the results of sensitivity tests on frequency elasticity in terms of airfare and traffic volume by increment of 0.05 each time from 0.1 to 0.6. As shown in the graphs, the airfare is negatively related to the frequency elasticity for all three routes. Although there is no consistent pattern for the change of traffic volume, it tends to decrease when passengers become sensitive to the frequency. The reason may be that, given the price elasticity, increasing flight frequency itself would not stimulate reasonable additional passengers to the market. Since carriers would have to charge a lower airfare, as rational entities that pursue maximization of profit, they would rather run fewer flights if passengers are sensitive to the flight frequency. Although the traffic volume may be negatively related to the frequency elasticity, it is interesting to note that, for all three routes, the results would be better even under the lower bound of frequency elasticity (0.6) compared to the situation under the base case.

Figure 6.9 Results of Sensitivity Tests on Elasticities – Price and Traffic Volume



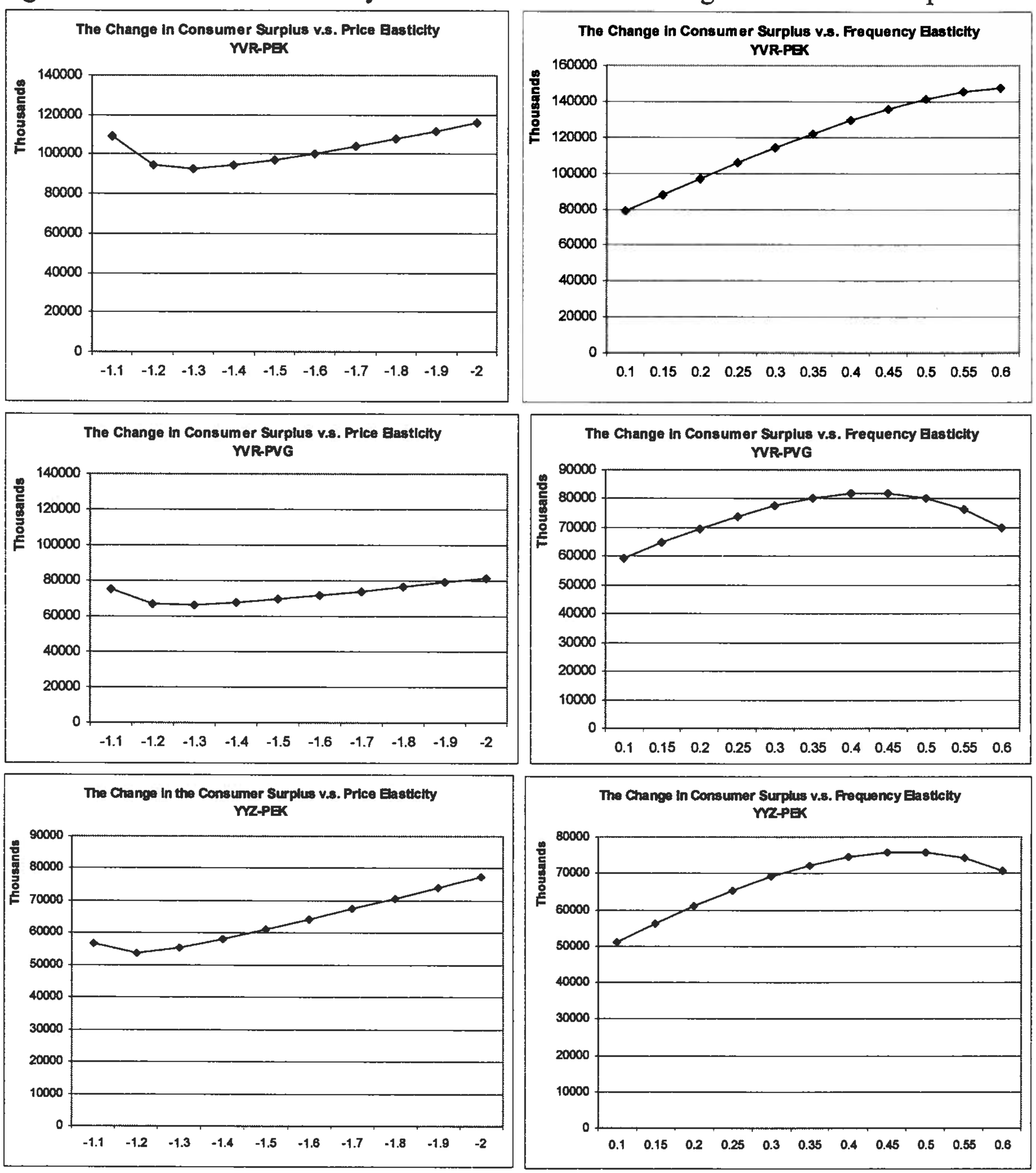
The graphs in Figure 6.10 show how the aggregate carriers' profit changes for each of the three routes as elasticities of demand with respect to price and flight frequency change. It is consistent that the aggregate carriers' profit would be positively related to price elasticity whereas negatively related to frequency elasticity for all three routes. This means that airlines would be able to earn more profits if passengers are sensitive to the price due to the economy of scale or economy of density. However, if passengers are sensitive to the frequency alone, carrier would have to charge lower airfare, offer fewer flights, and carry fewer passengers. Hence, the profit would decrease along with the increase of frequency elasticity.

Figure 6.10 Results of Sensitivity Tests on Elasticities – Aggregate Carriers' Profit



The graphs in Figure 6.11 capture the results of sensitivity tests on elasticities of demand with respect to price and flight frequency in terms of the change in consumer surplus. The graphs show that 1) the change in consumer surplus increases incrementally when passengers become sensitive to the price, 2) the change in consumer surplus increases at a decreasing rate when passengers become sensitive to the frequency.

Figure 6.11 Results of Sensitivity Tests on Elasticities – Change in Consumer Surplus



Again, the above figures only present the results by changing one variable. It might be of interest to capture the whole picture using a two-dimension measurement. Because of the limit of the space, such two-variable tables are shown in the Appendix A.3.

6.3. Summary

The empirical results presented in this chapter show that liberalization of bilateral air services between Canada and China would decrease airfares, improve quality of the air services, and increase volume of air traffic via stimulation. Although the carriers' profits would decrease, consumers would greatly benefit from the airfare reduction and the increase in the flight frequency. Therefore, as expected the aggregate economic welfare would increase with the Canada-China bilateral ASA liberalization.

In the sensitivity tests, we found that, with the change of the parameters of our computational model in reasonable ranges, the equilibrium average airfare would still be lower and traffic volume higher as compared to the base case. In addition, consumers would still be able to enjoy the additional gains due to the reduction of airfare and improvement of frequency. This implies air liberalization would have positive impacts on the Canada–China bilateral market even under the worst case scenario: i.e., the lower bounds of the parameter values.

Chapter 7. Conclusion

In this chapter, a short summary of this thesis is presented, followed by the summary of the key findings and contributions. Further research issues for future endeavor are also given.

7.1. Summary of the Study and Key Results

International air services are generally regulated by bilateral Air Services Agreements (ASAs) which are signed between each pair of nations linking the specific bilateral markets. Most of the traditional bilateral ASAs are producer-interest (airline oriented) agreements operated within the framework of the Chicago Convention. It has been argued that this type of agreements is restrictive and inefficient to serve international air services. Therefore, there have been rising calls for liberalization/deregulation of current bilateral ASAs towards consumer-interest agreements.

We observed that most of the existing bilateral ASAs between Canada and Asian countries are regulated by restricted bilateral ASAs.[36] Liberalization of air services between Canada and any of the Asian countries is expected to stimulate the market and attract additional passengers to the markets. This is especially so for the Canada–China market because China will continue to enjoy rapid economic growth in the foreseeable future and has a large population base, much of which are untapped for air transport market.

Our literature review reveals that the existing studies are insufficient to understand the magnitudes of the expected economic effects of air services liberalization for specific bilateral markets linking Canada and Asia. The objective of this thesis is, therefore, to contribute to understanding of the economic effects of liberalizing bilateral ASA between Canada and China. In order to achieve this objective, we developed a computable model to measure the economic effects of bilateral ASA liberalization, and applied to the case of Canada-China bilateral air services markets. The example cases of bilateral liberalization have been analyzed: namely, Case I (deregulation of price and flight capacity) and Case II

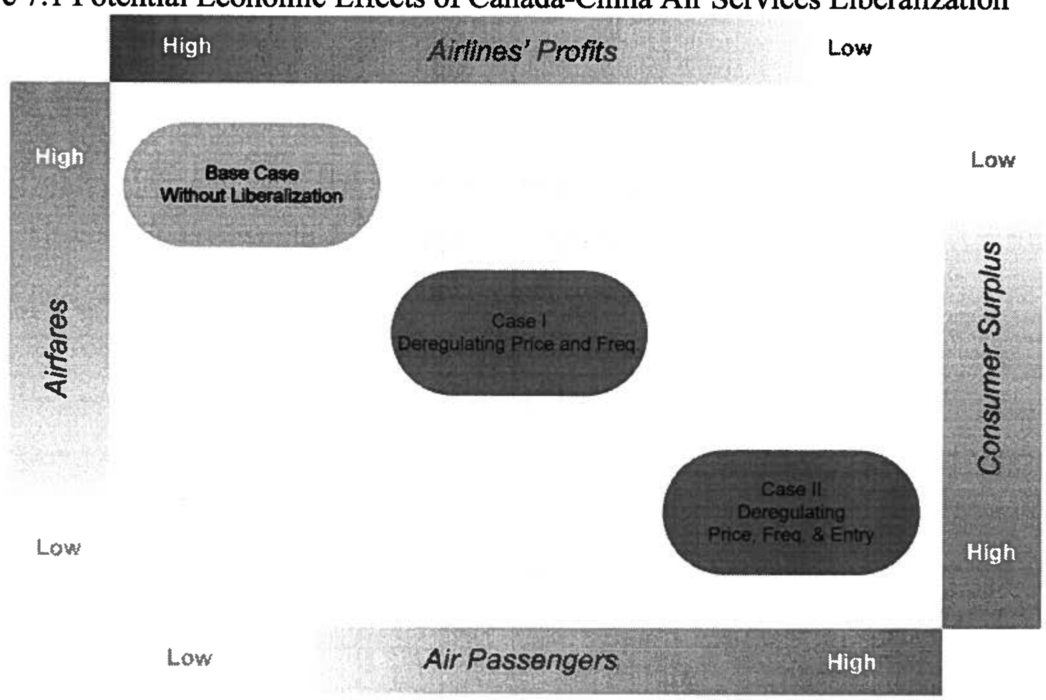
[36] The only exception is the announcement of Open Skies bilateral ASA between Canada and Korea on 15 July, 2009.

(complete deregulation of entry, price and flight capacity). The economic effects we quantified include the change in average prices each bilateral carriers charge, change in passenger volumes in the market, and market shares of each carrier as well as changes in consumer and producer (carriers) surpluses under each of the two deregulation cases.

The key findings with and without bilateral ASA liberalization for the Canada–China market are illustrated in Figure 7.1. The major expected effects of the Canada-China bilateral ASA liberalization can be summarized as follows:

- As compared to the Base case, the average airfares would decrease, on average, by 11.8% and 24.0%, respectively, under Case I and Case II;
- The total passenger volumes would increase by 25.8% and 49.8% under Case I deregulation and Case II deregulation, respectively;
- Although there would be a negative change of the carrier surpluses (profits), the increase in consumer surplus outweigh very significantly the loss in carrier surpluses. Therefore, the aggregate economic welfare would increase by US$67 million per year under Case I deregulation, and about US$ 110 million per year under Case II deregulation.

Figure 7.1 Potential Economic Effects of Canada-China Air Services Liberalization



7.2. Contributions of This Thesis

Most of the previous studies on air services liberalization are empirical studies that have used various forms of regression analysis to identify and estimate the effects of air liberalization. None of them is able to provide a direct insight of the expected effects of air services liberalization for a specific market where a liberalized ASA is not yet concluded. Only a few studies attempted to measure such impacts by constructing computable models. However, the models in these studies are either preliminary (Booz Allen Hamilton, 2007) or limited. For instances, some models fail to measure the effects with new entrance (the Productivity Commission, 1999) while others fail to estimate the effects internally with the change of the degree of competition (Gillen, Harris and Oum, 2002).

This study adopts a different approach by constructing an airlines profit maximization function. The model is able to capture the response of an airline in the market with and without air services liberalization. In addition, by introducing the conduct parameter, the model allows us to measure the expected economic effects of air services liberalization - under different degree of competitive inter-firm rivalry including the *Cournot* competition, the *Bertrand* competition or somewhere in between. Capturing the degree of competition is essential because carriers behave differently under different market situations. Even in the same market, the degree of competition can be different among routes. The market outcomes are likely to be influenced by the number of carriers existing in the routes, whether the existing carriers are alliance partner or not etc.

The empirical findings of this paper provide direct insights to policy makers and bilateral negotiators about the economic effects of liberalizing the Canada-China ASA. These quantitative evidences were not available in the past literature.

The computable model in this study can be applied not only to the Canada–China case, but also to any other bilateral markets in the world. With the data on a base case and the values of the parameters of the model, one can compute equilibrium prices and quantities for a specific bilateral market, and the carrier and consumer surpluses.

7.3. Future Research Needs

Ideally the model for analyzing bilateral ASAs should be able to capture effects of the change in a bilateral ASA between a pair of countries on:

(1) the origin-destination traffic between the two countries, say, country A and country B;

(2) the transit traffic coming from behind country A (B), say from country C to go country B (A) or to a point beyond country B via country A (B); and

(3) the pure through-traffic traveling between countries C and D with two connections at country A and country B.

However, because of the time and resource limitations available for this thesis and the limited data availability the scope of our thesis had to be limited only to the analysis of the total traffic volume between two pair of airports; for example, the total passenger volume moving between Vancouver (YVR) and Shanghai-Pudong (PVG) airports. In other words, our model does not allow the separate analysis of passengers' routing choice of (2) or (3) from the direct OD traffic (1).

Future research should deal with the transit traffic (2) and through-traffic (3) adequately as attracting their routing choice in favor of the liberalized bilateral routes is an important reason for bilateral policy liberalization and/or open skies.

Bibliography

Abunassar, W., Koford, K. (1994). A Reestimation of the Air transport Association Study of Airline Fares and Study of Airline Fares and Concentration. Logistics and Transportation Review, 30, 4, 363-378

Adler, N., Hashai, N. (2005). Effect of open skies in the Middle East region. Transportation Research Part A 39, 878-894

Air Transport Action Group (2008), The Economic and Social Benefits of Air Transport 2008.

Ashford, N., Bencheman, M. (1987). Passengers' Choice of Airport: An Application of the Multinomial Logit Model. Transportation Research Record, 1147, 1-5

Asia-Pacific Economic Cooperation (2008), The APEC Region, Trade and Investment, APEC.

Audretsch, D.B, Mata, J. (1995). The Post-Entry Performance of Firms: Introduction. International Journal of Industrial Organization 13, 413-419

Bailey, E.E., Graham, D.R., Kaplan, D.P. (1985). Deregulating the Airlines. The MIT Press.

Basar, G., Bhat, C. (2004). A Parameterized Consideration Set Model for Airport Choice: An Application to the San Francisco Bay Area. Transportation Research Part B 38, 889 - 904

Booz Allen Hamilton (2007). The Economic Impacts of An Open Aviation Area between the EU and the US, a report prepared for Directorate General Energy and Transport, European Commission.

Brander, J.A., Zhang, A. (1990). Market Conduct in the Airline Industry: An Empirical Investigation. Rand Journal of Economics, Vol. 21, No. 4

Brander, J.A., Zhang, A. (1993). Dynamic Oligopoly Behaviour in the Airline Industry. International Journal of Industrial Organization, 11, 407-435

Brooke, A.S., Caves, R.E., Pitfield D.E. (1994). Methodology for Predicting European Short-haul Air Transport Demand from Regional Airports. Journal of Air Transport Management 1(1), 37-46

Bureau of Transportation Statistics, the United States, Form 41 Traffic.

Caves, D.W., Christensen, L.R., Tretheway, M.W. (1983). Productivity Performance of U.S. Trunk and Local Service Airlines in the Era of Deregulation. Economic Inquiry, Vol. XXL, 312-324

Chicago Convention 1944, Article 6.

Douglas, G. W., and J. C. Miller (1974a). Quality Competition, Industry Equilibrium and Efficiency in Price-Constrained Markets. American Economic Review 64, 657-659

Dresner, M., Oum, T.H. (1998). The Effect of Liberalised Air Transport Bilaterals on Foreign Traffic Diversion: The Case of Canada. Journal of Transport Economics and Policy, V32, Part 3, 317-330

Dresner, M., Tretheway, M.W. (1992). Modeling and Testing the Effect of Market Structure on Price: The Case of International Air Transport. Journal of Transport Economics and Policy, 171-184

Fisher, T., Kamerschen, D.R. (2003). Price-Cost Margins in the US Airline Industry Using a Conjectural Variation Approach. Journal of Transport Economics and Policy, 227-259

Forsyth, P. (1997). The Gains from the Liberalisation of Air Transport. Journal of Transport Economics and Policy, Volume 32, Part 1, 73-92

Fu, X., Lijesen, M., Oum, T.H. (2006). An Analysis of Airport Pricing and Regulation in the Presence of Competition between Full Service Airlines and Low Cost Carriers. Journal of Transport Economic and Policy, 40, 425-448

Furuichi, M., Koppelman, F.S. (1994). An Analysis of Air Traveler's Departure Airport and Destination Choice Behaviours. Transportation Research, 28A, 187-195

Gillen, D., Harris, R., Oum, T.H. (2002). Measuring the economic effects of bilateral liberalization air transport. Transportation Research Part E 38, 155-174

Gillen, D., Hazledine, T. (2006). The New Price Discrimination and Pricing in Airline Markets: Implications for Competition and Antitrust. XIV Pan-American Conference of Traffic & Transportation Engineering, September 20th-23rd, 2006

Gillen, D., Hinsch, H. (2001). Measuring the economic impact of liberalization of international aviation on Hamburg airport. Journal of Air Transport Management 7, 25-34

Gillen, D., Morrison, W., Steward, C. (2003). Air Travel Demand Elasticities: Concepts, Issues and Measurement. Department of Finance Canada.

Harvey, G. (1987). Airport choice in a multiple airport region. Transportation Research. 21A, 439-449

Hazledine, T., Green, H., Haugh, D. (2003). The Smoking Gun? Competition and

Predation in the Trans-Tasman Air Travel Market. Economic working papers, The University of Auckland.

Hess, S. (2007). Posterior analysis of random taste coefficients in air travel behaviour modelling.

Hess, S., Polak, J.W. (2005). Mixed logit modelling of airport choice in multi-airport regions. Journal of Air Transport Management 11, 59 – 68

Hodgkinson (2007), Restrictions Across the Pacific: Australia's International Air Services Policy and the Problems of Liberalisation, The Hodgkinson Group Aviation Advisors.

Hofer, C, Dresner, M., Windle, R. (2004). Hub Premiums in an Era of Low-Cost Carriers and Financial Distress. Address at the 2004 Air Transport Research Society World Conference in Istanbul, Turkey

Hurdle, G.J., Johnson, R.L., Joskow, A.S., Werden, G.J., Williams, M.A. (1989). Concentration, Potential Entry, and Performance in the Airline Industry. Journal of Industrial Economics 38, 119-139

Inglada, V., Rey, B., Rodrı ′ guez-Alvarez, A., Coto-Millan, P. (2006) Liberalisation and Efficiency in International Air Transport. Transportation Research Part A 40, 95 – 105

International Civil Aviation Organization, ICAO Database of Aeronautical Agreements and Arrangement, ICAO.

International Civil Aviation Organization, ICAO Traffic By Flight Stage Database, ICAO

International Monetary Fund, IMF Database.

InterVISTAS (2006). The economic impact of air service liberalization.

Ippolito, R.A. (1981). Estimating Airline Demand with Quality of Service Variables. Journal of Transport Economics and Policy, January

Joskow, A.S., Werden, G.J., Johnson, R.L. (1994). Entry, Exit, and Performance in Airline Markets. International Journal of Industrial Organization 12, 457-471

Keeler, T. E. (1972). Airline Regulation and Market Performance. Bell Journal of Economics 3 (Autumn), 399-424

Koran, D.W. (1983). The Welfare Effects of Airline Fare Deregulation in The United States. Journal of Transport Economics and Policy, 177-189

Lloyd, P.J. and Zhang, Xiaoguang (2006). The Armington Model. Productivity

Commission Staff Working Paper.

Maillebiau, E. and Hansen, M. (1995). Demand and Consumer Welfare Impacts of International Airlines Liberalization: The case of the North Atlantic. Journal of Transport Economics and Policy, 115-136

Marin, P.L. (1995). Competition in European aviation: pricing policy and market structure. The Journal of Industrial Economics, Vol. 43, No. 2, 141-159

Manual on the Regulation of International Air Transport. Doc 9626, Part 4.

Morrison, S., Winston, C. (1986). The Economic Effects of Airline Deregulation. Washington, D.C.: The Brookings Institution.

Morrison, S.A., Winston, C. (2005). Competition and welfare in the U.S. airline industry. 2005

Outm, T.H., Waters II, W.G., Fu, X. (2006). Transport Demand Elasticities – Updated Dec. 2006.

Oum, T.H., Waters II, W.G., Yong, J.S. (1992). Concepts of price elasticities of transport demand and recent empirical estimates. Journal of Transport Economics Policy, 139-154

Oum, T.H., Yu, C. (1995). A productivity comparison of the world's major airlines. Journal of Air Transport Management 2 (3/4), 181-195

Oum, T.H., Yu, C. (1998). Cost competitiveness of the world's major airlines: an international comparison. Transportation Research A32 (6), 407-422

Oum, T.H., Zhang, A., Zhang, Y. (1993). Inter-Firm Rivalry and Firm-Specific Price Elasticities in Deregulated Airline Markets. Journal of Transport Economics and Policy 27, 171–192

Pels, E., Nijkamp, P., Rietveld, P. (2001). Airport Choice in a Multiple Airport Region: An Empirical Analysis for the San Francisco Bay Area. Regional Studies, Vol. 35.1, 1-9

Productivity Commission (1999). International Air Services, Report No. 2, AusInfo, Canberra.

Reynolds-Feighanan, A.J. (1995). European and American Approaches to Air Transport Liberalization: Some Implications for Small Communities. Transportation Research Part A, Vol. 29A, 6, 467-483

Schipper, Y., Rietveld, P., and Nijkamp, P. (2002), European Airline Reform: An

Emperical Welfare Analysis, Journal of Transport Economics and Policy, Volume 36, Part 2, 189-209

Schipper, Y., Nijkamp, P., and Rietveld, P. (2007), Deregulation and Welfare in Airline Markets: An Analysis of Frequency Equilibria. European Journal of Operational Research, 178, 194-206

Statistics Canada, Database from International Travel

Swan, W., Adler, N. (2006). Aircraft Trip Cost Parameters: A Function of Stage Length and Seat Capacity, Transportation Research E, 42, 105-115

Thompson, A., Caves, R. (1993). The Projected Market Share for A New Small Airport in the South of England. Regional Studies, 27, 137-147

Transport Canada (2006), A New International Air Transportation Policy.

Appendices

Appendix A.1 Key Terminology of Air Transport

<u>Freedom of the Air</u>

First Freedom of the Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State or States to fly across its territory without landing (also known as a ***First Freedom Right***).

Second Freedom of the Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State or States to land in its territory for non-traffic purposes (also known as a ***Second Freedom Right***).

Third Freedom of The Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State to put down, in the territory of the first State, traffic coming from the home State of the carrier (also known as a ***Third Freedom Right***).

Fourth Freedom of The Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State to take on, in the territory of the first State, traffic destined for the home State of the carrier (also known as a ***Fourth Freedom Right***).

Fifth Freedom of The Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State to put down and to take on, in the territory of the first State, traffic coming from or destined to a third State (also known as a ***Fifth Freedom Right***).

ICAO characterizes all "freedoms" beyond the Fifth as "so-called" because only the first five "freedoms" have been officially recognized as such by international treaty.

Sixth Freedom of The Air - the right or privilege, in respect of scheduled international air services, of transporting, via the home State of the carrier, traffic moving between two other States (also known as a ***Sixth Freedom Right***). The so-called Sixth Freedom of the Air, unlike the first five freedoms, is not incorporated as such into any widely recognized air service agreements such as the "Five Freedoms Agreement".

Seventh Freedom of The Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State, of transporting traffic between the territory of the granting State and any third State with no requirement to include on such operation any point in the territory of the recipient State, i.e the service need not connect to or be an extension of any service to/from the home State of the carrier.

Eighth Freedom of The Air - the right or privilege, in respect of scheduled international air services, of transporting cabotage traffic between two points in the territory of the granting State on a service which originates or terminates in the home country of the foreign carrier or (in connection with the so-called Seventh Freedom of the Air) outside the territory of the granting State (also known as a ***Eighth Freedom Right*** or "**consecutive cabotage**").

Ninth Freedom of The Air - the right or privilege of transporting cabotage traffic of the granting State on a service performed entirely within the territory of the granting State (also known as a ***Ninth Freedom Right*** or "***stand alone" cabotage***).

Source: *Manual on the Regulation of International Air Transport* (Doc 9626, Part 4)

Tariff

Single Disapproval - one government may disapprove a tariff which fails to meet certain pre-established conditions.

Double Disapproval - tariff proposed by carriers become operative unless both of the governments disapproved.

Appendix A.2 Carriers Quality Index

YVR – PEK Route

Alternative routes	Carriers	Carriers Quality	5 competitors	3 competitors
YVR – PEK	Air Canada	3.25	0.95	1.02
YVR – PEK	Air China	2.63	0.77	0.83
YVR – ICN – PEK	Korea Air	3.60	1.06	
YVR – NRT – PEK	Japan Airlines	3.89	1.14	
YVR – HKG – PEK	Cathay Pacific	3.67	1.08	1.15

YVR – PVG Route

Alternative routes	Carriers	Carriers Quality	5 competitors	3 competitors
YVR – PVG	Air Canada	3.25	0.96	1.03
YVR – PVG	China Eastern	2.53	0.75	0.80
YVR – ICN – PVG	Korea Air	3.60	1.06	
YVR – NRT – PVG	Japan Airlines	3.89	1.15	
YVR – HKG – PVG	Cathay Pacific	3.67	1.08	1.16

YYZ – PEK Route

Alternative routes	Carriers	Carriers Quality	5 competitors	3 competitors
YYZ – PEK	Air Canada	3.25	0.99	1.02
YYZ – PEK	Air China*	2.63	0.80	0.83
YYZ – ICN – PEK	Korea Air	3.60	1.10	
YYZ – NRT – PEK	Air Canada	3.25	0.99	
YVR – HKG – PEK	Cathay Pacific	3.67	1.12	1.15

* new entrance

Note that there are other possible combinations during the simulation. However, due to the limited space, they will not be presented.

Appendix A.3 Carriers Adjusted CASK, 2006

YVR – PEK Route

	Total Operating Cost (US$ million)	ASK (million)	Average Stage Length (km)	CASK (US cents)	Adj. CASK (US cents)
Air Canada	6,430	98,283	1,405	6.542	4.564
Air China	4,141	83,492	1,727	4.960	3.606
Korea Air	4,684	71,895	2,308	6.515	4.950
Japan Airlines	8,246	87,987	1,667	9.372	6.598
Cathay Pacific	4,498	89,118	4,255	5.047	4.086

YVR – PVG Route

	Total Operating Cost (US$ million)	ASK (million)	Average Stage Length (km)	CASK (US cents)	Adj. CASK (US cents)
Air Canada	6,430	98,283	1,405	6.542	4.510
China Eastern	3,775	70,468	1,435	5.358	3.709
Korea Air	4,684	71,895	2,308	6.515	4.960
Japan Airlines	8,246	87,987	1,667	9.372	6.644
Cathay Pacific	4,498	89,118	4,255	5.047	4.138

YYZ – PEK Route

	Total Operating Cost (US$ million)	ASK (million)	Average Stage Length (km)	CASK (US cents)	Adj. CASK (US cents)
Air Canada	6,430	98,283	1,405	6.542	4.366
Korea Air	4,684	71,895	2,308	6.515	4.726
Air Canada (NRT)	6,430	98,283	1,405	6.542	4.250
Cathay Pacific	4,498	89,118	4,255	5.047	3.986

Appendix A.4 Sensitivity Tests

YVR – PEK Route: Conduct Parameters vs. Load Factors

Airfare

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	706.85	658.12	616.35	580.16	548.48	520.54	495.69	473.47
-0.2	694.45	643.42	599.68	561.77	528.60	499.33	473.32	450.04
-0.4	656.24	608.02	566.69	530.86	499.52	471.86	447.28	425.28
-0.6	622.02	576.31	537.13	503.18	473.47	447.25	423.95	403.10
-0.8	591.19	547.75	510.51	478.24	450.00	425.09	402.94	383.12
-1	563.28	521.88	486.41	455.66	428.75	405.01	383.91	365.03

Traffic Volume

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	257,993.00	290,784.30	325,112.44	360,954.60	398,288.87	437,094.00	477,349.27	519,034.39
-0.2	286,900.68	315,059.56	343,461.70	372,073.04	400,863.71	429,807.32	458,880.42	488,062.03
-0.4	310,761.05	341,261.79	372,026.02	403,016.85	434,201.93	465,552.66	497,043.65	528,652.18
-0.6	335,168.33	368,064.61	401,245.08	434,669.94	468,304.31	502,117.34	536,081.64	570,172.71
-0.8	360,105.57	395,449.40	431,098.56	467,010.31	503,147.13	539,475.93	575,967.25	612,594.77
-1	385,557.12	423,398.98	461,567.76	500,017.67	538,708.58	577,605.02	616,675.48	655,891.76

Profit of Air Canada

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	17,512,631.89	18,537,530.47	19,576,017.42	20,628,661.70	21,695,858.60	22,777,873.21	23,874,871.24	24,986,941.70
-0.2	19,601,555.01	19,952,776.60	20,281,994.13	20,591,890.41	20,884,667.06	21,162,155.06	21,425,895.06	21,677,196.80
-0.4	16,988,494.12	17,295,487.68	17,583,475.58	17,854,774.78	18,111,286.41	18,354,591.40	18,586,019.84	18,806,702.36
-0.6	14,464,179.08	14,729,274.76	14,978,282.90	15,213,164.38	15,435,527.86	15,646,710.81	15,847,838.26	16,039,866.38

Profit of Air China

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	19,056,059.07	20,223,075.04	21,408,364.06	22,612,441.98	23,835,648.22	25,078,190.10	26,340,174.37	27,621,630.20
-0.2	19,109,856.81	19,425,899.59	19,719,848.46	19,994,403.10	20,251,781.10	20,493,828.52	20,722,100.11	20,937,918.77
-0.4	17,549,292.83	17,834,873.36	18,100,054.75	18,347,331.14	18,578,751.68	18,796,022.47	19,000,580.63	19,193,649.16
-0.6	16,411,735.39	16,672,012.34	16,913,054.93	17,137,217.48	17,346,434.75	17,542,318.08	17,726,225.07	17,899,311.33

Profit of New Entrance

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	3,976,893.75	4,418,081.76	4,881,102.94	5,365,803.09	5,872,011.91	6,399,545.99	6,948,211.20	7,517,804.43
-0.2	3,351,480.28	3,414,034.12	3,472,889.23	3,528,496.37	3,581,225.28	3,631,383.25	3,679,228.72	3,724,981.27
-0.4	1,015,569.82	1,036,059.22	1,055,468.48	1,073,929.38	1,091,549.86	1,108,419.52	1,124,613.64	1,140,196.09
-0.6	23,266.74	23,129.56	22,958.99	22,760.12	22,537.15	22,293.61	22,032.49	21,756.33

CS

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	30,247,677.48	49,267,785.75	67,158,320.52	84,057,930.38	100,080,186.14	115,319,378.05	129,854,715.52	143,753,432.83
-0.2	40,000,193.51	58,266,523.94	75,361,290.52	91,428,344.35	106,585,652.88	120,931,265.20	134,547,636.45	147,504,827.82
-0.4	58,948,812.26	77,570,769.77	94,998,028.33	111,377,211.82	126,828,569.78	141,452,054.47	155,331,726.54	168,539,015.39
-0.6	77,212,522.61	96,177,030.30	113,924,588.55	130,604,490.78	146,339,183.24	161,230,449.84	175,363,896.21	188,812,268.16
-0.8	94,177,992.37	113,458,930.61	131,502,562.56	148,460,629.45	164,457,590.91	179,596,908.86	193,965,603.72	207,637,626.35

YVR – PEK Route: Price Elasticities vs. Frequency Elasticities

Airfare

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	612.90	595.33	578.82	563.28	548.63	534.80	521.71
-1.1	598.44	583.22	568.83	555.19	542.25	529.96	518.27
-1.2	586.95	573.54	560.78	548.63	537.05	526.00	515.43
-1.3	577.59	565.61	554.17	543.22	532.74	522.70	513.06
-1.4	569.83	559.01	548.63	538.67	529.10	519.90	511.05
-1.5	563.28	553.42	543.94	534.80	526.00	517.51	509.32
-1.6	557.69	548.63	539.90	531.46	523.31	515.43	507.81
-1.7	552.86	544.48	536.39	528.55	520.97	513.62	506.49
-1.8	548.63	540.85	533.31	526.00	518.90	512.01	505.33
-1.9	544.92	537.65	530.59	523.73	517.07	510.59	504.29
-2	541.62	534.80	528.17	521.71	515.43	509.32	503.36

Frequency

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	1,927.85	1,874.89	1,803.98	1,707.25	1,571.79	1,375.68	1,081.57
-1.1	2,084.34	2,043.23	1,986.08	1,905.05	1,786.74	1,606.91	1,319.94
-1.2	2,250.68	2,223.85	2,183.66	2,122.75	2,027.83	1,873.39	1,606.94
-1.3	2,427.70	2,417.79	2,398.14	2,362.33	2,298.11	2,180.27	1,952.04
-1.4	2,616.23	2,626.13	2,630.97	2,625.95	2,601.00	2,533.42	2,366.53
-1.5	2,817.12	2,849.98	2,883.73	2,915.95	2,940.26	2,939.50	2,863.83
-1.6	3,031.22	3,090.51	3,158.09	3,234.89	3,320.08	3,406.13	3,459.86
-1.7	3,259.45	3,348.96	3,455.84	3,585.54	3,745.11	3,941.97	4,173.52
-1.8	3,502.73	3,626.63	3,778.92	3,970.91	4,220.50	4,556.87	5,027.28
-1.9	3,762.06	3,924.93	4,129.39	4,394.32	4,751.98	5,262.05	6,047.73
-2	4,038.47	4,245.34	4,509.49	4,859.36	5,345.88	6,070.29	7,266.43

Traffic Volume

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	310,505.16	302,134.97	290,891.82	275,505.63	253,889.96	222,488.42	175,209.40
-1.1	335,853.39	329,409.63	320,405.39	307,579.21	288,762.77	260,025.06	213,942.91
-1.2	362,801.52	358,680.58	352,437.96	342,886.73	327,884.27	303,297.46	260,589.86
-1.3	391,486.72	390,118.02	387,216.43	381,752.92	371,755.01	353,143.81	316,697.13
-1.4	422,044.03	423,896.16	424,980.14	424,528.97	420,929.21	410,518.90	384,104.02
-1.5	454,610.08	460,196.24	465,983.82	471,596.18	476,021.41	476,510.47	464,996.50
-1.6	489,325.41	499,208.65	510,499.91	523,369.41	537,713.45	552,357.65	561,971.30
-1.7	526,336.16	541,134.63	558,820.66	580,300.63	606,762.06	639,471.69	678,111.58
-1.8	565,795.18	586,187.59	611,260.11	642,882.55	684,007.16	739,459.58	817,076.39
-1.9	607,863.15	634,594.42	668,156.11	711,652.46	770,380.99	854,150.68	983,206.17
-2	652,709.36	686,596.69	729,872.36	787,196.45	866,918.13	985,626.90	1,181,647.40

CS

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1.1	79,399,883	109,086,520	126,398,376	125,219,211	96,137,245	24,351,531	-113,098,283
-1.2	72,603,731	94,421,760	110,743,069	118,540,205	112,985,153	86,078,129	24,239,879
-1.3	73,532,257	92,837,090	109,089,677	120,365,457	123,485,429	112,914,657	78,471,721
-1.4	76,140,026	94,350,882	110,856,661	124,352,143	132,601,160	131,514,094	112,978,966
-1.5	79,297,878	97,033,720	113,984,581	129,283,064	141,379,608	147,286,534	140,610,507
-1.6	82,672,911	100,279,887	117,820,288	134,785,224	150,209,545	162,102,126	165,811,658
-1.7	86,147,934	103,852,463	122,105,251	140,721,851	159,289,326	176,822,405	190,646,734
-1.8	89,680,266	107,647,732	126,725,074	147,042,283	168,745,381	191,934,618	216,308,382
-1.9	93,256,709	111,618,294	131,627,307	153,732,950	178,672,580	207,764,268	243,624,305
-2	96,876,671	115,743,227	136,789,304	160,798,365	189,150,932	224,561,018	273,263,647

Aggregate Carriers' Profit

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	51,342,817	44,946,271	38,814,195	32,876,479	27,032,782	21,122,471	14,876,034
-1.1	50,943,425	45,290,588	39,831,749	34,498,489	29,182,029	23,688,404	17,644,408
-1.2	51,134,041	46,124,637	41,270,880	36,508,660	31,726,920	26,709,437	20,993,163
-1.3	51,795,076	47,368,402	43,085,242	38,890,645	34,680,766	30,234,651	25,028,425
-1.4	52,850,077	48,972,391	45,249,507	41,642,448	38,067,593	34,324,535	29,877,935
-1.5	54,249,267	50,906,378	47,752,062	44,772,112	41,920,113	39,051,006	35,694,506
-1.6	55,960,195	53,152,944	50,590,795	48,295,256	46,278,728	44,498,025	42,660,307
-1.7	57,962,153	55,703,587	53,770,571	52,233,668	51,191,139	50,762,631	50,992,043
-1.8	60,242,705	58,556,307	57,301,673	56,614,489	56,712,329	57,956,319	60,947,145
-1.9	62,795,463	61,714,049	61,198,828	61,469,788	62,904,813	66,206,727	72,831,118
-2	65,618,614	65,183,700	65,480,605	66,836,375	69,839,071	75,659,634	87,006,249

YVR – PVG Route: Conduct Parameters vs. Load Factors

Airfare

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	683.97	635.86	594.63	558.90	527.63	500.04	475.51	453.57
-0.2	657.81	611.69	572.16	537.90	507.92	481.47	457.96	436.92
-0.4	643.93	596.68	556.17	521.07	490.36	463.26	439.17	417.61
-0.6	610.35	565.56	527.17	493.90	464.79	439.10	416.27	395.84
-0.8	580.10	537.53	501.04	469.42	441.75	417.34	395.64	376.22
-1	552.70	512.15	477.38	447.25	420.89	397.63	376.95	358.45

Traffic Volume

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	202,975.96	228,228.27	254,637.41	282,195.65	310,896.23	340,733.13	371,700.90	403,794.56
-0.2	225,147.75	254,397.56	285,160.76	317,432.89	351,210.11	386,489.00	423,266.43	461,539.47
-0.4	253,921.36	278,799.88	303,886.23	329,150.26	354,565.53	380,108.74	405,759.16	431,498.28
-0.6	273,864.43	300,696.93	327,753.57	355,001.84	382,413.24	409,962.62	437,627.64	465,388.31
-0.8	294,240.53	323,069.41	352,139.13	381,414.73	410,865.59	440,464.71	470,188.06	500,014.19
-1	315,036.87	345,903.32	377,027.63	408,372.37	439,904.76	471,595.89	503,420.02	535,354.20

Profit of Air Canada

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	13,790,098.96	14,740,175.90	15,714,199.69	16,712,673.89	17,735,987.06	18,784,440.64	19,858,268.82	20,957,652.92
-0.2	13,088,837.04	14,129,302.69	15,204,308.18	16,314,222.96	17,459,329.99	18,639,846.10	19,855,936.53	21,107,725.43
-0.4	15,255,205.73	15,938,381.64	16,619,935.38	17,300,764.82	17,981,561.62	18,662,861.74	19,345,081.77	20,028,545.40
-0.6	13,425,402.52	14,172,280.42	14,925,866.70	15,686,584.52	16,454,719.91	17,230,456.65	18,013,901.02	18,805,099.92
-0.8	12,677,781.74	13,652,087.65	14,651,765.93	15,676,623.56	16,726,396.54	17,800,769.33	18,899,388.58	20,021,873.19

Profit of China Eastern

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	9,769,607.64	9,915,883.92	10,050,329.34	10,174,368.26	10,289,172.05	10,395,716.93	10,494,826.11	10,587,200.85
-0.2	9,091,943.55	9,220,970.41	9,338,788.25	9,446,744.75	9,545,948.81	9,637,325.16	9,721,653.92	9,799,600.05
-0.4	8,330,927.45	7,919,491.42	7,504,079.25	7,088,025.04	6,674,072.30	6,264,498.99	5,861,210.16	5,465,807.85
-0.6	6,263,663.61	5,747,758.20	5,241,974.13	4,749,863.20	4,274,325.70	3,817,745.54	3,382,090.87	2,968,990.53
-0.8	4,183,583.22	3,505,096.71	2,876,862.14	2,303,415.57	1,788,391.78	1,334,705.77	944,688.96	620,193.77

Profit of New Entrance

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	4,627,082.22	5,157,835.91	5,718,040.26	6,307,835.82	6,927,341.22	7,576,656.44	8,255,865.22	8,965,037.02
-0.2	3,438,997.78	3,957,714.66	4,515,318.63	5,112,078.97	5,748,234.75	6,423,997.83	7,139,555.45	7,895,072.45
-0.4	2,612,335.97	2,829,669.18	3,053,611.74	3,284,091.79	3,521,025.26	3,764,319.22	4,013,874.33	4,269,586.58
-0.6	665,513.37	793,244.96	932,267.23	1,082,497.90	1,243,841.03	1,416,189.22	1,599,425.45	1,793,424.59
-0.8	279,423.00	185,989.49	110,722.56	54,418.75	17,697.17	1,034.19	4,789.85	29,228.11

CS

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	3,997,525.03	19,910,447.45	34,912,718.06	49,117,245.25	62,616,456.23	75,487,037.21	87,793,366.24	99,590,051.20
-0.2	15,624,538.18	31,920,873.54	47,298,756.16	61,872,092.59	75,734,108.10	88,962,135.20	101,621,081.37	113,765,992.51
-0.4	26,400,127.14	41,832,101.98	56,294,972.06	69,907,804.89	82,768,191.98	94,957,205.98	106,542,992.94	117,583,429.46
-0.6	41,115,104.11	56,977,689.65	71,858,142.18	85,876,953.06	99,132,866.20	111,707,900.29	123,670,987.73	135,080,666.21
-0.8	55,656,382.90	72,260,944.07	87,878,661.04	102,629,924.06	116,613,344.11	129,910,792.83	142,591,052.54	154,712,514.74
-0.9	63,190,564.77	80,871,367.46	97,574,561.40	113,417,110.71	128,494,775.27	142,887,040.92	156,660,685.18	169,872,409.70

YVR – PVG Route: Price Elasticities vs. Frequency Elasticities

Airfare

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	560.71	548.55	536.95	525.88	515.31	505.19	495.51
-1.1	550.71	540.06	529.85	520.06	510.66	501.62	492.94
-1.2	542.68	533.21	524.09	515.31	506.85	498.69	490.82
-1.3	536.08	527.55	519.32	511.37	503.68	496.24	489.04
-1.4	530.57	522.81	515.31	508.04	500.99	494.16	487.53
-1.5	525.88	518.78	511.89	505.19	498.69	492.37	486.23
-1.6	521.86	515.31	508.94	502.73	496.70	490.82	485.09
-1.7	518.37	512.29	506.36	500.58	494.95	489.46	484.10
-1.8	515.31	509.63	504.10	498.69	493.41	488.26	483.22
-1.9	512.60	507.29	502.09	497.01	492.04	487.19	482.43
-2	510.20	505.19	500.30	495.51	490.82	486.23	481.73

Frequency

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	1,610.16	1,526.78	1,422.99	1,291.74	1,122.98	903.07	617.82
-1.1	1,725.08	1,647.68	1,549.95	1,424.21	1,258.96	1,037.33	737.87
-1.2	1,846.47	1,776.41	1,686.45	1,568.38	1,409.42	1,189.49	879.27
-1.3	1,974.80	1,913.54	1,833.22	1,725.29	1,575.86	1,361.82	1,045.64
-1.4	2,110.53	2,059.65	1,991.05	1,896.02	1,759.89	1,556.87	1,241.17
-1.5	2,254.12	2,215.34	2,160.75	2,081.74	1,963.28	1,777.49	1,470.77
-1.6	2,406.04	2,381.25	2,343.18	2,283.72	2,187.97	2,026.88	1,740.10
-1.7	2,566.79	2,558.02	2,539.28	2,503.31	2,436.09	2,308.60	2,055.79
-1.8	2,736.88	2,746.36	2,750.02	2,741.98	2,709.97	2,626.68	2,425.48
-1.9	2,916.83	2,946.98	2,976.45	3,001.30	3,012.14	2,985.60	2,858.11
-2	3,107.22	3,160.67	3,219.69	3,282.98	3,345.41	3,390.38	3,363.98

Traffic Volume

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	282,025.81	267,335.46	249,063.73	225,981.46	196,339.13	157,768.07	107,819.80
-1.1	302,075.70	288,424.65	271,206.01	249,078.46	220,040.91	181,160.00	128,725.67
-1.2	323,251.72	310,876.35	295,007.72	274,213.40	246,263.89	207,666.84	153,344.70
-1.3	345,635.05	334,789.95	320,597.91	301,563.68	275,265.87	237,683.42	182,305.16
-1.4	369,305.73	360,266.71	348,111.62	331,319.12	307,328.47	271,652.01	216,337.80
-1.5	394,344.52	387,411.35	377,691.31	363,683.50	342,759.78	310,068.11	256,292.33
-1.6	420,834.09	416,333.08	409,487.92	398,876.09	381,897.06	353,486.86	303,156.30
-1.7	448,859.88	447,146.41	443,661.83	437,133.08	425,109.61	402,530.14	358,077.10
-1.8	478,510.72	479,971.80	480,383.73	478,709.07	472,801.90	457,894.48	422,387.27
-1.9	509,879.26	514,936.26	519,835.50	523,878.62	525,416.89	520,359.85	497,633.75
-2	543,062.47	552,173.87	562,211.04	572,937.88	583,439.70	590,799.48	585,611.80

CS

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1.1	60,006,795	74,932,210	75,313,644	55,566,524	8,144,430	-76,512,032	-207,580,569
-1.2	55,226,577	67,039,657	71,755,634	66,413,915	46,859,901	7,474,885	-58,121,148
-1.3	55,725,771	66,542,250	72,810,294	72,466,732	62,513,361	38,655,827	-4,641,584
-1.4	57,376,596	67,771,130	74,946,309	77,309,286	72,467,969	56,814,446	25,195,096
-1.5	59,403,200	69,634,521	77,492,956	81,689,420	80,226,164	69,943,314	45,916,018
-1.6	61,574,295	71,792,043	80,247,258	85,875,479	86,975,774	80,734,793	62,417,260
-1.7	63,806,855	74,112,028	83,135,168	89,995,334	93,241,185	90,366,779	76,848,008
-1.8	66,069,421	76,537,770	86,128,405	94,122,329	99,297,051	99,449,896	90,332,685
-1.9	68,351,122	79,043,980	89,217,548	98,304,578	105,306,707	108,343,715	103,545,935
-2	70,649,983	81,619,939	92,401,756	102,577,063	111,377,853	117,283,582	116,943,464

Aggregate Carriers' Profit

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	33,673,221	28,753,907	23,996,792	19,378,625	14,876,909	10,479,662	6,229,115
-1.1	33,126,402	28,653,171	24,282,484	19,984,039	15,720,097	11,448,054	7,150,732
-1.2	32,931,317	28,833,325	24,794,436	20,777,558	16,730,263	12,579,095	8,241,873
-1.3	33,012,058	29,241,694	25,499,494	21,742,491	17,904,928	13,883,490	9,527,219
-1.4	33,318,414	29,843,873	26,376,937	22,870,207	19,246,746	15,375,763	11,036,253
-1.5	33,816,290	30,617,065	27,414,094	24,157,488	20,762,140	17,073,854	12,803,742
-1.6	34,482,155	31,546,178	28,603,758	25,604,973	22,460,533	18,998,986	14,870,391
-1.7	35,299,652	32,621,440	29,942,601	27,216,208	24,353,916	21,175,711	17,283,671
-1.8	36,257,471	33,836,884	31,430,169	28,997,056	26,456,608	23,632,071	20,098,796
-1.9	37,347,952	35,189,358	33,068,227	30,955,330	28,785,162	26,399,851	23,379,889
-2	38,566,152	36,677,863	34,860,327	33,100,563	31,358,344	29,514,906	27,201,335

YYZ – PEK Route: Conduct Parameters vs. Load Factors

Airfare

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	971.63	910.88	858.82	813.69	774.21	739.37	708.40	680.69
-0.2	918.99	861.78	812.74	770.25	733.06	700.25	671.08	644.99
-0.4	910.08	847.60	794.05	747.64	707.03	671.19	639.34	610.84
-0.6	834.98	777.65	728.52	685.94	648.68	615.80	586.58	560.43
-0.8	771.32	718.37	672.98	633.65	599.23	568.86	541.86	517.71
-1	716.69	667.49	625.31	588.76	556.78	528.56	503.48	481.04

Traffic Volume

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	103,895.22	115,676.01	127,743.87	140,072.77	152,638.55	165,418.67	178,392.12	191,539.29
-0.2	119,187.47	133,496.21	148,243.46	163,394.17	178,915.46	194,776.40	210,947.90	227,402.61
-0.4	144,196.69	157,190.71	170,122.97	182,979.49	195,748.70	208,421.01	220,988.50	233,444.59
-0.6	162,840.69	177,514.78	192,119.13	206,637.94	221,058.15	235,368.94	249,561.34	263,627.95
-0.8	182,129.70	198,541.99	214,876.27	231,114.88	247,243.21	263,249.16	279,122.70	294,855.55
-1	202,034.29	220,240.24	238,359.66	256,372.95	274,263.92	292,019.12	309,627.45	327,079.71

Profit of Air Canada

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	23,664,533.73	24,816,217.86	25,957,591.81	27,089,274.17	28,211,681.43	29,325,087.27	30,429,663.93	31,525,511.66
-0.2	23,994,201.88	25,321,668.85	26,645,193.29	27,964,755.24	29,280,200.33	30,591,287.64	31,897,722.54	33,199,179.43
-0.4	29,937,435.92	30,394,748.41	30,816,985.87	31,208,502.40	31,572,875.75	31,913,084.87	32,231,638.85	32,530,672.59
-0.6	28,754,418.94	29,193,660.13	29,599,212.32	29,975,257.56	30,325,232.22	30,651,997.53	30,957,963.44	31,245,180.46
-0.7	29,099,122.25	29,543,628.99	29,954,042.87	30,334,596.08	30,688,766.19	31,019,448.71	31,329,082.48	31,619,742.62

Profit of New Entrance

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	6,343,377.30	6,904,563.63	7,477,048.21	8,059,877.64	8,652,139.64	9,252,965.00	9,861,528.06	10,477,046.39
-0.2	4,728,606.81	5,287,200.52	5,866,293.43	6,464,444.00	7,080,276.18	7,712,478.98	8,359,805.42	9,021,070.96
-0.4	4,588,593.49	4,658,687.03	4,723,404.53	4,783,413.35	4,839,261.86	4,891,406.66	4,940,232.30	4,986,066.03
-0.6	1,097,731.71	1,114,500.23	1,129,982.63	1,144,338.57	1,157,699.24	1,170,173.87	1,181,854.45	1,192,819.28
-0.7	75,737.95	76,894.89	77,963.10	78,953.59	79,875.41	80,736.09	81,542.00	82,298.51

CS

	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
0	18,463,861.35	29,219,671.06	39,175,970.57	48,433,339.31	57,074,284.19	65,167,392.27	72,770,343.27	79,932,140.37
-0.2	30,781,390.16	41,723,959.95	51,851,518.78	61,266,564.34	70,053,184.94	78,281,288.25	86,009,669.32	93,288,282.65
-0.4	36,176,230.86	47,517,864.45	58,041,924.41	67,850,476.77	77,027,255.09	85,641,876.00	93,752,896.64	101,410,078.15
-0.6	54,599,220.14	66,231,256.32	77,022,541.67	87,077,985.80	96,483,666.51	105,311,158.22	113,620,671.73	121,463,378.93
-0.7	63,538,513.37	75,311,736.06	86,232,910.35	96,408,332.13	105,925,221.94	114,856,108.60	123,262,008.98	131,194,782.63
-0.8	72,312,453.16	84,224,403.38	95,273,188.07	105,566,467.36	115,192,586.40	124,225,013.20	132,725,557.89	140,746,756.68

YYZ – PEK Route: Price Elasticities vs. Frequency Elasticities

Airfare

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	881.80	844.78	810.99	780.01	751.50	725.19	700.83
-1.1	851.26	819.91	790.97	764.17	739.29	716.12	694.50
-1.2	827.51	800.36	775.09	751.50	729.44	708.75	689.32
-1.3	808.51	784.60	762.19	741.14	721.33	702.64	685.00
-1.4	792.96	771.62	751.50	732.50	714.53	697.50	681.35
-1.5	780.01	760.75	742.50	725.19	708.75	693.11	678.21
-1.6	769.04	751.50	734.82	718.93	703.78	689.32	675.50
-1.7	759.65	743.55	728.18	713.50	699.46	686.01	673.12
-1.8	751.50	736.63	722.40	708.75	695.66	683.10	671.03
-1.9	744.38	730.56	717.30	704.56	692.31	680.52	669.17
-2	738.09	725.19	712.78	700.83	689.32	678.21	667.50

Frequency

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	563.19	533.50	495.54	446.76	383.74	302.21	198.98
-1.1	614.52	586.84	550.91	503.85	441.54	358.21	247.54
-1.2	669.18	644.33	611.39	567.25	507.11	423.72	307.19
-1.3	727.58	706.40	677.54	637.68	581.51	500.31	380.37
-1.4	790.05	773.49	749.91	715.93	665.87	589.78	470.06
-1.5	856.96	846.05	829.11	802.86	761.51	694.23	579.84
-1.6	928.68	924.56	915.79	899.42	869.89	816.08	714.08
-1.7	1,005.59	1,009.52	1,010.66	1,006.64	992.63	958.12	878.07
-1.8	1,088.07	1,101.45	1,114.47	1,125.66	1,131.58	1,123.59	1,078.21
-1.9	1,176.55	1,200.94	1,228.04	1,257.75	1,288.81	1,316.25	1,322.25
-2	1,271.46	1,308.59	1,352.28	1,404.29	1,466.65	1,540.40	1,619.58

Traffic Volume

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	119,959.79	113,636.51	105,549.42	95,160.81	81,737.66	64,371.76	42,382.41
-1.1	130,892.03	124,997.47	117,342.86	107,320.18	94,047.69	76,299.35	52,725.54
-1.2	142,536.37	137,242.29	130,226.64	120,823.83	108,015.38	90,253.14	65,431.12
-1.3	154,973.56	150,463.35	144,315.66	135,825.74	123,861.02	106,566.18	81,019.51
-1.4	168,280.45	164,753.70	159,730.76	152,493.38	141,831.23	125,623.64	100,122.34
-1.5	182,533.29	180,209.51	176,600.80	171,009.92	162,202.63	147,871.14	123,505.87
-1.6	197,809.76	196,931.66	195,064.27	191,576.46	185,285.84	173,824.21	152,099.26
-1.7	214,190.27	215,027.01	215,270.64	214,414.12	211,429.85	204,079.14	187,028.63
-1.8	231,758.95	234,609.36	237,381.74	239,766.36	241,026.76	239,325.49	229,658.06
-1.9	250,604.40	255,800.36	261,573.04	267,901.33	274,517.20	280,360.48	281,639.09
-2	270,820.31	278,730.35	288,034.99	299,114.53	312,396.25	328,105.49	344,970.35

CS

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1.1	42,858,532	56,781,577	60,755,783	51,203,720	23,673,319	-26,660,167	-102,433,523
-1.2	42,225,350	53,598,666	59,987,167	59,424,650	49,339,754	26,663,574	-11,094,215
-1.3	44,841,817	55,294,993	62,484,331	64,990,796	60,875,141	47,632,692	22,702,865
-1.4	47,998,409	58,015,152	65,678,451	69,855,070	68,933,102	60,685,488	42,437,800
-1.5	51,240,351	61,058,937	69,113,739	74,457,011	75,689,692	70,760,603	56,882,079
-1.6	54,462,092	64,231,484	72,671,176	78,972,957	81,901,202	79,544,724	69,029,250
-1.7	57,644,739	67,472,078	76,320,260	83,498,667	87,915,339	87,795,973	80,230,683
-1.8	60,794,988	70,764,892	80,059,628	88,096,996	93,925,553	95,926,098	91,231,751
-1.9	63,927,076	74,111,042	83,898,674	92,814,863	100,056,677	104,195,446	102,519,249
-2	67,056,789	77,518,399	87,850,969	97,690,658	106,399,718	112,791,631	114,462,302

Aggregate Carriers' Profit

	0.10	0.20	0.30	0.40	0.50	0.60	0.70
-1	37,896,426	31,862,653	26,217,959	20,899,447	15,848,144	11,017,810	6,425,142
-1.1	37,510,555	32,098,230	26,956,762	22,023,838	17,227,823	12,487,257	7,743,980
-1.2	37,625,902	32,726,470	28,015,090	23,426,574	18,874,106	14,236,867	9,366,879
-1.3	38,134,416	33,680,912	29,358,663	25,099,082	20,800,639	16,302,719	11,357,181
-1.4	38,969,284	34,922,003	30,970,253	27,043,575	23,028,788	18,729,075	13,792,391
-1.5	40,088,402	36,426,783	32,843,640	29,269,897	25,586,447	21,568,775	16,766,900
-1.6	41,465,330	38,183,148	34,980,219	31,793,794	28,507,569	24,884,036	20,395,369
-1.7	43,084,055	40,186,495	37,387,026	34,635,978	31,832,105	28,747,553	24,816,852
-1.8	44,935,825	42,437,687	40,075,562	37,821,639	35,606,217	33,243,889	30,199,793
-1.9	47,017,165	44,941,782	43,061,093	41,380,246	39,882,692	38,471,144	36,748,083
-2	49,328,597	47,707,224	46,362,232	45,345,536	44,721,501	44,542,919	44,708,350