An empirical examination of the Canadian air passenger market: distinguishing the impact of LCC and ULCC market entry

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN BUSINESS ADMINISTRATION

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Business Administration - Transportation and Logistics)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

June 2023

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An empirical examination of the Canadian air passenger market: distinguishing the impact of LCC and ULCC market entry

submitted by Nargess Ovesy in partial fulfilment of the requirements for

the degree of Master of Science in Business Administration

in Transportation and Logistics

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Abstract

The emergence of low-cost carriers (LCCs) after U.S. deregulation in 1978 and the more recent developments of ultra-low-cost carriers (ULCCs) has transformed the aviation industry in the United States and Europe. There are numerous studies that examine the impact of LCCs, and subsequently, ULCCs on airfares and air travel demand in both the U.S. and Europe. Recently, researchers have become interested to look into the aviation markets in South East Asia, such as China and Singapore. One reason for this focus in the research could be the availability and transparency of data in these regions. However, for the first time, we now have access to rich and detailed data for the Canadian aviation market spanning from 2014-2019. In this research, we focused on domestic travel within Canada and identify the factors that impact airfares and air travel demand within the country. Additionally, we employ econometric tools to determine the effects of the introduction of Flair an ULCC, as well as Swoop an LCC, into the Canadian aviation market. Furthermore, we have conducted a thorough analysis of the market's price elasticity of demand and have provided reasoning for its lower value compared to the literature's findings in other countries.

Lay Summary

The emergence of LCCs and ULCCs in the aviation industry have had a dramatic impact on air passenger demand. In the EU, passengers have the option to switch to other modes of transportation, such as railways, which are well-established and sometimes faster than air travel. On the other hand, both the U.S. and Canada are twice the size of Europe with no rail alternative. These are just a few examples of the differences between the aviation market in North America, and EU that have been the focus of previous research. Our study distinguishes between the effects of Flair, an ULCC, and Swoop, a LCC, on the level of airfares and passenger demand in Canada. Using econometric tools and analyzing the data in detail, we obtain new and original results identifying the variables that influence demand and airfares in Canada, and the extent to which they do.

Preface

This thesis is original, unpublished, independent work by the author, Nargess Ovesy, under the supervision of Prof. David Gillen.

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List of Abbreviations

These abbreviations are used the most:

- AWA: Airline Within Airline
- EU: European Union
- FSC: Full Service Carrier
- LCC: Low Cost Carrier
- U.S.: United States of America
- ULCC: Ultra-low Cost Carrier

Acknowledgements

I would like to express my sincere gratitude to my supervisor, Prof. David Gillen whose support and wisdom made writing this thesis possible. Throughout my master's journey, he has been an invaluable source of guidance and knowledge, and I have learned a great deal from him.

I would like to thank my family, especially my mother, father, and dear sister, for their unwavering emotional support throughout this process. Their encouragement has been instrumental in keeping me motivated and focused.

Lastly, I would like to extend my thanks to the people who are closest to my heart, and who have generously offered their assistance whenever I needed it.

Dedication

To all brave women of my country, Iran.

Women, Life, Freedom

Chapter 1: Introduction

One of the most important outcomes of airline deregulation in U.S. in 1978 was the introduction of new airline business models and in particular the rise of low-cost carriers (LCCs). With deregulation in Europe starting in 1993, the phenomenon of LCCs spread to Europe and to the Asia Pacific region a decade later. There is significant literature documenting how the LCCs have reduced the cost of air travel and forced a fundamental restructuring of many existing full-service network carriers (FSCs) in the EU and U.S.[1].

The evidence in the U.S. shows that the emergence of LCCs, over the medium to longer term, grew the market for air travel; initially, in the U.S., LCC traffic came from other modes and from other activities and it was only once LCCs had a realized a 20 percent market share did they divert traffic from the FSC.[2] For the last three decades, the U.S., European and Asian airline industries have been shaped, to a large degree, by the growth of LCCs like Southwest Airlines and JetBlue Airways. LCCs have been able to offer lower fares in the markets they serve and operate business models and network structures that are markedly different from their legacy counterparts. LCCs maintain simplicity in organization, in network structure and in fare setting. This provides a basis for their lower unit costs and their ability to charge lower fares. The traditional network legacy carriers like American and Delta Air Lines, on the other hand, have complexity in their organization, in their hub-and-spoke network structure and in their fare setting.

[1] A detailed discussion of LCCs (low-cost carriers) and FSCs (full-service network carriers) is contained in Chapter 2 which reviews the literature on airline business models and the impact of these differing business models on fares, service quality and network design.
[2] This stealing is what forced the FSC to improve their efficiency, reduce their cost structure and enhance the sophistication of their revenue management systems.

The emergence and growth of LCCs in Europe were shaped by a different set of forces than in the U.S. Two important differences were Europe had a well-developed passenger rail system unlike the U.S. and secondly, Europe was compact, distances were not long and LCCs could easily run 2 to 2.5-hour stage lengths which allowed high utilization of their key factors notably aircraft and flight & cabin crew.[3] The EU also had a large number of airports, a legacy of WWII and these provided low cost operating bases for LCCs. The EU deregulated its air transport sector in three tranches, meaning they deregulated slowly, unlike the U.S. This approach to deregulation had important outcomes. Unlike the U.S., each European country had its own government-owned flag carrier and having a low rollout to deregulation meant the inefficient government carriers could entrench their positions. In many cases, they tried to establish low-cost airlines within their own airline structure (much like 'fighting brands' that had been tried in other industries), a strategy which was never successful. Nonetheless, the LCC business model still emerged and was simply slowed by the way in which the EU was deregulated.

Because the EU had a well-established passenger rail system as well as a sophisticated intercity bus system in those countries that were not sufficiently densely populated or too small to support a sophisticated passenger trail network, LCCs could not easily take passengers from other modes or other activities and did 'steal' passenger share from the FSC. Although they also grew the market considerably with their low fares and their novel approach to network design and utilization; for example, a European LCC like Ryanair had few origins, flew to many destinations a few times per week and therefore achieved significant geographic coverage with an initial relatively small fleet of aircraft.

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[3] The U.S. and Europe have dissimilar populations; in 2010, for example, the U.S. has approximately 310 million while EU27 has 501 million. This meant EU27 was much denser and was able to support more airlines and certainly more LCCs.

In 1998, the relative share of the LCC market segment in Europe was close to zero, by 2019, it reached 31.9 percent. LCCs typically offer point-to-point services, instead of hub and spoke, on short haul routes with a single aircraft type (B737, A320) to achieve low operating costs per passenger and high aircraft productivity.

In the beginning the LCCs growth was mostly concentrated in Western Europe, but after 2004 LCCs progressively expanded into Central and Eastern Europe. LCCs tend to operate mostly at small/reginal airports to avoid waiting time resulting from the congestion and also to pay less to the airports in landing fees and charges, yet there were and are LCC entries in the large hub airports in Europe. An LCC like Easyjet, for example, has a business model in which they cater to small businesses and businessmen by offering frequent service to a smaller number of origins/destinations and operating out of major airports.

Canada's domestic airline industry has evolved quite different from that of the EU and U.S. This evolution has been a product of a low and relatively sparsely distributed population, having a long thin market in which hubs tend to be directional, generally east-west and having a dominant government airline that was finally privatized in 1988 but which still receives significant government protection in many different forms. Deregulation was driven by two or three fundamental forces. First, the demonstration effect from deregulation in the U.S. showed lower fares, more service and greater geographic coverage were an outcome of greater competition, second, there was a general deregulation movement in most western democracies, essentially getting government out of markets which could be competitive and third, the recognition that aviation development was important to grow tourism and trade and government did not have the resources to invest in the needed infrastructure to promote these activities. Canada deregulated its airline industry with the proclamation of the new National Transportation Act, in 1987.[4]

The evolution of Canada's airline industry is not unlike the railway industry; a public firm and a private firm operating in a tightly regulated environment and given parts of the world in which they would have exclusive rights. TransCanada Airlines which started in 1930 as a government owned firm competed with Canadian Pacific Airlines. Each had their own spheres of the world which were exclusive to them but not to other nations carriers. Survival required active participation beyond the domestic market into the transborder (U.S. and Mexico) and international markets. As generally happened, the Federal government granted Air Canada increasing rights to areas previously the purview of Canadian Pacific (which evolved into Canadian Airlines International though a series of mergers with smaller regional carriers). With the privatization of Air Canada in 1988 and the continued protection offered to Air Canada through bilateral agreements, Canadian Airlines went bankrupt and was folded into Air Canada to create a monopoly, effective in 1999. Canadian Airlines bankruptcy was accelerated when in 1995, an upstart LCC, WestJet modelled after Southwest Airlines in the U.S. grew and flourished in western Canada helped by the growing western oil economy. A combination of WestJet capturing much of the western domestic market and Air Canada encroaching on Canadian's International markets contributed to Canadian Airlines demise. Canada was left after 1999 with two carriers; a LCC and a dominant full-service network carrier.

Over the period from 2000 through to 2015 Air Canada competed with WestJet on a nationwide basis with aggressive tactics on the part of Air Canada. This airline was charged with predatory behavior in 2003 against WestJet and it, Air Canada, went into creditor protection

[4] Airline deregulation officially became law on 1 January 1988.

(CCAA in Canada) for a period. Again, the Federal government massaged some rules that allowed it to emerge from bankruptcy. Over the same period there were a series of smaller carriers that sought to enter the market but near all eventually failed even those operating under the umbrella of Air Canada.[5] A significant problem with any new entrant is being fully capitalized. In Canada, there is a restriction on foreign ownership of airlines, holding it to 50%. The Canadian capital market is simply not large enough not sufficiently risk taking that it can support an airline industry expansion. These ownership restrictions have helped to preserve Air Canada's dominance since they serve as a barrier to entry.

The fact Canada has a small population and is characterized by large distances and cold winters makes a few factors essential for success. First, airlines must participate in the U.S. market. This is largely because this is primarily a leisure destination (except for some key business destinations such as New York, Boston, Houston, Los Angeles and Chicago). Canada's cold snowy winters means what are west-east markets in the summer become North-South markets in the winter. Furthermore, participating in international markets is important not essential but a success factor nonetheless. International markets are still governed by international bilateral agreements and although the U.S. has numerous open skies agreements with other countries, Canada has very few.[6] WestJet evolved from being a LCC to being a 'value-based airline' [VBA] that offers similar services and aircraft types as a FSC but does not have a hub-and-spoke network and still has some

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[5] In the post 1988 period, a number of startup carriers emerged in Canada, all doomed to failure. Examples included Air 2000 Canada, Airtransit, Canada 3000, Canjet, City Express, Eastern Provincial, Great Lakes, Greyhound, Holidair, Intair, Jetsgo, Nationair, Nordair, Norontair, PWA, Quebecair, Royal, Skyservice, Tango, Time Air, TransairVistajet, Voyageur, Wardair, Worldways, Zip and Zoom.The stumbling blocks for these start-ups were the combination of the restrictive foreign ownership rules in scheduled passenger air transport, the small Canadian capital market and the low tolerance for risk by Canadians.

[6] Canada also restricts foreign carrier's access to Canada's market, to protect Air Canada. Carriers such as Turkish, Emirates, Etihad, Qatar and some European carriers are restricted to 3 times per week is because it is impossible to build a market, particularly one that will attract high yield business passengers.

cost advantages and can charge lower fares, if it wishes. Essentially, Air Canada and WestJet act as a duopoly. It is the combination of WestJet abandoning its LCC business model and it participating as a duopolist that has created the opportunity for true LCCs and ULCCs to enter the Canadian market.

Evolution of the ULCCs

As economies grew, per capita incomes increased, greater urbanization occurred and immigration spread, there was an expansion of the demand for air carriers. Successful LCCs developed innovative policies to reduce their costs even more and increase revenue by charging passengers for services that were traditionally rolled into the price of an air ticket. What was happening is rather than having a bundled product which did not provide passengers with choice, the new thinking was to unbundle the product, offer base air fares and let passengers rebundle the product to suit their needs, to customize the product they wished to consume. People Express, in U.S. could be a good example to elaborate more on this, it was founded in 1981, introduced a $3 checked baggage fee and charged for onboard snack/meal service (Gross and Lück, 2013). Arguably, some carriers like People Express were the first to incorporate some aspects but not all of the ULCC model, such as the generation of additional revenues through ancillary fees.

Somewhat similar to the LCCs, established in U.S., the first airline to sustainably operate using a ULCC- like model was not in United States, but in Europe. In the early 1990s, facing losses, the Irish carrier Ryanair restructured its business model to incorporate the features that would soon become hallmarks of ULCCs. By charging for ancillary services such as airport counter check-in, checked baggage, printing boarding passes and on-board food and beverage, they were able to offer low base fares starting from £59.[7] Ryanair pioneered the aggressive pricing strategy, charging for ancillary items such as boarding passes and airport counter check-in, that is a major facet of the ULCC model today. A competing airline, easyJet, also began practicing some of the same strategies in European markets. In Canada, Flair Airlines is the first successful ULCC and travels to medium and large population centers in Canada. The differing business models, FSC, LCC and ULCC as well as Schedule-Charter carriers like Sunwing (and the previous Wardair) raise the question as to whether this variety of models can co-exist in the marketplace and are there necessary conditions that are needed for such co-existence to be sustainable? It would make the differences between airlines clearer if we can group the characteristics of the ULCC model as below:

1. It has significantly lower costs than any other airline for the same flight;

2. It generates a significant portion of its operating revenue through the sale of unbundled, ancillary services; and

3. As a result of lower base fares, it realizes lower unit revenues than other carriers, even when ancillary revenues are taken into account.

Another type of business model that emerged during this time period is the "airline-within-airline" (AWA) concept (Morrell, 2005; Gillen and Gados, 2008; Pearson and Merkert, 2014). As a competitive response to lower-cost airlines, some FSCs, in the U.S., Canada and Europe, introduced separate low-cost divisions or subsidiaries. These AWAs, were designed to compete directly with the LCCs, with the goal of achieving a lower cost structure and a more leisure travel-

[7] Ryanair also pioneered the strategy of having airports pay to have Ryanair provide services. The complementarity between airport non-aviation revenue and passenger traffic, meant it was attractive for an airport to have as many passengers as possible.

friendly product offering than their parent NLC (network legacy carriers) . However, in practice, none of the U.S. AWAs were able to compete and drive the LCCs out of the market, due in part to union pressure from the parent NLC (Pearson and Merkert, 2014). Thus, the last AWA in the U.S. TED by United was shuttered in January 2009 when United merged TED's operations back into mainline service. Air Canada also had a number of forays into the AWA strategy with Jetsgo, Tango, Zip and Zoom, all of which failed within 2 years of inception. Air Canada has been successful with the introduction of Rouge, its in-house LCC, largely for the reason it has treated it almost like a seasonal scheduled-charter carrier, it does not compete head-to-head on any route and it uses Rouge to develop and grow thin markets which the mainline carrier may eventually take over. It also is used to serve markets too small for Air Canada but can be served seasonally and it creates capacity that forecloses the market to another Canadian carrier. WestJet has been successful with their AWA strategy with their carrier ‘Swoop’. Unlike Air Canada, the mainline carrier, WestJet transferred considerable traffic to Swoop and avoided direct head-to-head competition. Swoop is not used in the same strategic way as is Rouge used by Air Canada.

Considering all the facts stated above, the airline market in Canada did not evolve and grow as did aviation markets in the U.S. and Europe after airline deregulation. Having a smaller population than the U.S. and Europe, not having access to numerous airports, as was the case in both the U.S. and Europe, being dominated by a single airline alliance (Star) which resulted in higher fares domestically, on transborder routes and internationally certainly stifled market. An important decision by the federal government was, despite having introduced deregulation, Canada continued to protect the former government owned carrier, Air Canada from competition and provided it with near exclusivity to access high yield international markets. A final, and key, decision made by the government, principally Transport Canada, was to limit access to aviation data after 1988, the year Air Canada was privatized. This was an important decision because it created a considerable barrier to entry and removed most all of the transparency of what was happening in aviation markets in Canada.

Topics of the Thesis

The research undertaken in this thesis was motivated by two outcomes. The first was access to a granular aviation data set that provided information for the Canadian domestic market on flights, fares and passenger demand by airline by route. The data covered the period 2014 through 2022 for all routes in Canada. For a number of reasons (Covid19 pandemic from March 2020 through 2021, the grounding of the Boeing 737MAX for a period of time) the data utilized covered the period 2014 through 2018. Secondly, there was entry into the Canadian market by a LCC (Swoop) and by a ULCC (Flair) and this entry occurred in the period covered by our data.

There are three main research questions.

(A) What factors influence airfares and passenger demand in the Canadian aviation market?

(B) What is the fare elasticity of demand in the Canadian domestic market for both short haul and long-haul traffic?

(C) Does the impact on fares and market growth by a LCC differ from that of a ULCC?

Because the Canadian government restricts access to aviation data there have not been (except possibly within government) any estimates of fare elasticities based solely on Canadian data. Any elasticities that have been estimated have been based on highly aggregated data and were for Canada as a whole. There has been speculation that the fare elasticities are similar between Canada and the U.S. but there is no firm basis for such a conclusion. Because data have been made available to the CRSs (Computer Reservation Systems), these data are collected, organized and marketed for sale to airlines and airports.[8]

As for the third question, it emerges naturally from the very fact that the ULCC business model was introduced; why was there room in the market for such a type of carrier and why was there room on the demand function for air travel?

In the second chapter of this research, we investigate and summarize the literature related to the topics mentioned earlier, such as the entry of LCCs and ULCCs into the aviation markets of the U.S. and the European Union. We discuss their impact on the market structure and provide a comprehensive and categorized literature review for further information. Additionally, detailed information can be found in the table provided in Appendix 1.

In the third chapter, we present details about the characteristics of the dataset and perform data analysis, which significantly enhances the clarity of our research and paves the way for the subsequent stages of our study.

Moving on to the fourth chapter, we present the theoretical model based on the insights gathered from the literature review discussed in this chapter. We introduce the fare model and passenger model, outlining the independent variables that we believe have an impact on the dependent variables in both models. Furthermore, we highlight the tests that we plan to conduct in order to validate the effectiveness of our model.

In the fifth chapter, we implement the aforementioned models on the dataset and analyze the results. We calculate the price elasticity and provide explanations for the outcomes obtained

[8] The data used in this thesis was purchased from Cirium-DiiO.

from the regression models. Lastly, we conduct tests on the models to ensure the accuracy and reliability of the results.

Finally, in the research conclusion, we summarize the findings and insights obtained from our study. We draw conclusions based on the analysis of the data and the results of the regression models. We highlight the key implications and contributions of our research to the field. Additionally, we discuss ideas for future research on this topic. We identify areas that require further exploration and suggest potential avenues for future studies. These ideas may include expanding the scope of the research, exploring additional variables, or investigating different markets or regions.

Chapter 2: Literature Review

There has been considerable research on the impact of market structure on the level and structure of prices. Few industries have undergone as much examination as the air transport industry particularly in the U.S. where detailed route and carrier information are easily available. U.S. airline deregulation provided fertile ground to study how changes in the numbers and size distribution of firms could impact prices and service levels (Chen,2017). The introduction of low-cost carriers (LCCs) and ultra-low-cost carriers (ULCC) provided the opportunity to examine how entry by different business models would affect price levels and structure. Researchers have found the actual or even potential entry of LCCs into markets reduces airfares, sometimes significantly, often leading to a doubling or tripling in passenger demand.[9] Most of the previous research as Goolsbee and Syverson (2008) indicated is that incumbent airlines tend to cut fares in response to actual entry as well as the "threat" of entry by Southwest Airlines (the U.S.'s most successful LCC). Windle, and Dresner (1998), found the entry of Valuejet (LCC in the U.S.) would reduce the prices of Delta (FSC-full-service carrier) but they did not find evidence that Delta increased fares on the routes not faced with competition to compensate for the loss resulting from the entry of LCCs.[10] Morrison (2001) stated that Southwest Airlines is frequently credited with having an important influence on the success of airline deregulation in the United States. He used an original set of competition variables to estimate the extent of the influence Southwest Airlines had on airfares through actual, adjacent, and potential competition. His findings showed that Southwest's

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[9] A good example is provided by Bellingham Airport in Washington state that experiences a more than doubling of traffic when allegiant (a ULCC) entered the market. The market increased by another 50 percent when Southwest (A LCC) entered.

[10] This is what theory would predict. Airlines maximize profits on their routes. If one route faces entry, it is not profit maximizing to try to increase fares on low or non-competition routes since the carriers were maximizing profits already.

low fares were directly responsible for $3.4 billion of savings to passengers.

Gillen and Morrison (2003), explored the interaction between full-service carriers (FSCs) and low-cost carriers in a market for air travel, of which flying is merely one component in a bundle of services. The paper employed a locational approach to product differentiation to provide insights concerning the degree to which LCCs compete with FSCs. This approach highlighted the role of airports in both geographic location relative to the travel market and as independent business entities that generate both airside and groundside revenues. A simple address model is used to illustrate conditions under which LCCs (affiliated with subsidiary airports) only constitute partial competition for FSCs. Consequently, market interactions between FSCs and LCCs can exhibit price stability and relatively low price dispersion. The model also indicates that vertical relationships between airports and airlines can be both profit enhancing and socially desirable.

It is not only the entry of LCCs which can change the airfares but also that the possibility of entry could alter the situation. Darabana and Fournier (2008) found evidence incumbent carriers also cut airfares in anticipation of entry by the LCCs. Moreover, fares remain lower even after the LCC exits.[11] Their empirical analysis confirmed the spatial dependence among airfares in adjacent routes, provided estimates of the consumer benefits from lower airfares in routes affected by LCCs and showed that there are substantial indirect benefits, i.e., lower fares in spatially-linked, nearby routes. They found that the indirect effects of LCCs, which are completely overlooked in the OLS specification represent up to 20 percent of the total welfare effect.

Brueckner, Lee, and Singer (2013) extended the research on the fare impacts of low-cost carriers, incorporating its adjacent-airport approach to offer a comprehensive picture of the

[11] The empirical study focused upon Southwest Airlines which some regard as a special case of an LCC because of its size and extensive route network.

competitive effects of both legacy carriers and low-cost carriers. They offered a regression model for non-stop and connecting flights. The results showed that most forms of legacy-carrier competition have weak effects on average fares. Low-cost carrier competition with a legacy carrier, on the other hand, has dramatic fare impacts, whether it occurs on the airport pair, at adjacent airports, or as potential competition.

Gayle and Wu (2013) Identified the situations in which potential entrants are effective “competitive threats” to incumbents in the market. The generalized method of moments (GMM) was used to estimate parameters in the profit equation, while ordinary least square was used to estimate parameters in the pricing equation. This paper provided evidence that even when a potential entrant has a presence at both endpoint airports of a market, incumbents may not respond to this as an effective "entry threat". Specifically, they found that incumbents, lower prices by more when the potential entrant has a hub at one or both market endpoints; and increase rather than lower their price if they have an alliance partnership with the "potential entrant".

As the above papers illustrated, the entry of LCCs into a market has an effect on the price level and market structure. However, there is a question whether airfares would change uniformly across different fare classes on demand side, or if it may affect special groups more than others? Chandra and Lederman (2018) revisited the relationship between competition and price discrimination. They concluded that if consumers differ in terms of both their underlying willingness to pay and their brand loyalty, competition may increase price differences between some consumers while decreasing differences between others. They estimate the effect of competition on some specific fares and identified the impact of market structure on fares by exploiting changes in the number of carriers serving a route over time. They developed an instrumental variables (IV) strategy to ensure the results presented are not influenced by the potential endogeneity of the market structure measures. Empirically, they found that competition has little impact at the top or the bottom of the fare class distribution but a significant impact in the middle.

The reaction to the entry of LCCs may not be the same on regional and trunk routes. Gillen and Hazledine (2015) searched for a difference between the determinants of pricing on regional routes and main trunk routes. They estimated a standard augmented gravity model of the log of the number of seats available daily on all 209 regional and the sample of 22 main trunk routes. They used logs of origin and destination populations as the gravity attractors, and log of air distance between cities or regional centers as the presumed deterrent factor for travel. They had not identified a significant effect of distance on the supply of seats and were justified in treating HHI as an exogenous variable in their system. They estimated a well-specified airfare model, which showed strong effects of competition on prices, quite substantial intertemporal price discrimination, and interesting differences between regional and main trunk route pricing. They concluded that if any new airline whether being LCC or not, enters one of the regional routes incumbent prices simply lower because of the effect of market competition. Also, Fageda and Flores-Fillol (2012) examined the differences between the U.S. regional markets and EU regional markets and found significant differences. In the EU, LCCs entered regional routes with low frequencies and low-cost airports to achieve lower costs and prices, while LCCs in the U.S. entered trunk markets and use density economies to achieve lower costs. In the U.S., regional jets were used to build markets, have higher frequencies (higher service quality) and with higher fares. Regional markets in the EU were oriented toward leisure passengers while in the U.S. business passengers were targeted.

Decreasing the prices was not the only strategy implemented by FSCs in response to LCCs' entry, the airline within airline (AWA) strategy has been another response by a number of airlines around the world to combat the aggressive growth of LCCs that followed the deregulation of the airline industry between 1970 and 2000. Although almost all the AWAs did not survive in the U.S. market, Raynes and Tsui (2019) used case studies to examine the evolution of the AWA strategy at the Singapore Airlines Group and the Australian Qantas Group between 2000 and 2016 in order to identify why these airlines operate AWAs successfully. High levels of autonomy, clear strategies, complementary route networks, appropriate resources, and minimal cannibalization were identified as the primary attributes required for a successful AWA operation. They showed that Legacy airlines whose AWA strategy failed in the past often did not operate with all these essential attributes, which resulted in their AWAs undermining and competing directly with their own operations. On the other hand, many FSCs chose to use multi strategies to combat LCCs, Nigel Dennis (2007) examined FSCs, British Airways and Lufthansa's competitive responses to the LCCs' entry. These are found to include reductions in labor costs, greater use of regional aircraft, and a run-down of secondary hubs. He concluded they changed their business in a way to be more similar to the LCCs and lower their costs but still keep many of the FSCs' characteristics such as first and business-class tickets in a limited number. Also, Homsombat, Zheng and Fu (2013) investigated the effects of the airlines-within-airlines strategy adopted by Qantas airline group, which simultaneously runs a full-service airline (Qantas Airways) and a low-cost carrier (Jetstar Airways) on pricing and route entry patterns. They showed that Jetstar has been used as a fighting brand against low-cost carriers, such a strategy increases group airlines' prices at the expense of rival airlines. Pricing benefits to Qantas Group come from increased market power as well as service quality.

It is not only the effect of entry of LCCs on airfares that had been investigated but also the researchers went further and explored the decision made by the LCCs to enter or exit a route. Boguslaski1, Ito, and Lee (2004) confirmed that U.S. LCCs have concentrated their entry over the past decade primarily on dense city-pair markets that allow them to leverage their comparative cost advantage. They demonstrated that if LCCs continue to penetrate markets of similar density at the same rate, the proportion of domestic network carrier revenue that may ultimately be exposed to non-stop LCC competition could rise sharply in the future.

Oliveira (2008) investigated the competition between low-cost carriers in rapid expansion and full-service network carriers by analyzing the entry of the low-cost Gol Airlines, in the Brazilian domestic market, in 2001. He used Amemiya's Generalized Least Squares (AGLS) to estimate a route-choice model associated with a flexible post-entry equilibrium profits equation, in which some of the regressors were treated as endogenous. Results indicated the importance of market size and rival's route presence as underlying determinants of profitability.

Detzen et al (2012) explored the impact of low-cost carriers' entry on legacy airline stock prices. Oligopoly structures, entry barriers, and high fixed costs make the airline industry highly susceptible to the competitive and network expansion impact of low-cost airlines' entry. Two methodologies were used; stock price event studies and Gaussian statistical analysis. Positive stock returns were observed, which were interpreted as the spillover effects of network expansion. Thus, rising passenger traffic and improving connectivity increase the revenues of legacy airlines to sufficiently offset the LCCs' competitive threats.

Atallah et al (2018) analyzed low-cost carrier (LCC) competition strategies for Continental U.S. domestic markets using time series analysis. They stated that LCCs have gravitated more towards serving large markets (i.e. Large-Large and Large-Medium), including entering markets that already have two or three competitors present. Post-recession, LCCs have shown a preference for competing with major carriers over other LCC airlines.

Vadlamani et al (2022) used machine learning to analyze and predict entry patterns of Southwest Airlines into various city pairs. The purpose was to understand the parameters impacting the decision to enter into a city pair, by a low-cost airline. They estimate the factors that motivate an LCC to enter a city-pair market based on certain exogenous (independent) factors. They predicted (in-sample) the most possible or likely candidates for future non-stop entry by using supervised machine learning to understand and predict a low-cost airline's decision to enter (exit) a specific city pair. They found that the most important factor influencing Southwest Airlines' decision to fly on a specific route is recognized to be the already existing infrastructure that Southwest has in place in either of the city pairs. This reflects network externality, which means it benefits from existing infrastructure and human resources that are already in place in a city.

Scotti and Dresner (2022) found that NCs (network carriers) have reacted to LCC competition mainly by operating more centralized and less transitive air networks, a strategy consistent with strengthening hub-and-spoke structures. They used Social Network Analysis method, finding the measures of Networks for LCCs and NCs for all years in the dataset and showed that LCCs have driven the NCs to centralize their network structures. This structure has decreased the density of the networks, reducing non-stop point-to-point routings by the NCs.

More recently, research has focused on the passengers' choice of airlines and routes as an important factor in LCCs' survival on specific routes; Lurkin et al (2018) provided a choice model to forecast the probability an airline passenger chooses a specific itinerary. They extended the prior analysis to include inter-itinerary competition along three dimensions: nonstop versus connecting levels of service, carrier, and time of day using nested logit (NL) and ordered generalized extreme value (OGEV) models; these are the first NL and OGEV itinerary choice models to correct for price endogeneity. They concluded that customer preferences, on average, have been stable over time and are similar across distribution channels.

The effects of “low-cost carriers” (LCCs) such as Southwest Airlines and JetBlue Airways on the competitive landscape of the U.S. airline industry have been thoroughly documented in the academic literature and the popular press. However, the more recent emergence of another distinct airline business modeled, the ultra-low-cost cost carrier” (ULCC) has received considerably less attention, Bachwich and Wittman (2018), conducted an analysis of ULCCs in the U.S. aviation industry and demonstrated how these carriers' business models, costs, and effects on air transportation markets differ from those of the traditional LCCs. They used a two-way fixed effects econometric model to isolate the effects of ULCC and/or LCC presence on base market airfares. They found that in 2015, ULCC presence in a market was associated with market base fares 21 percent lower than average, as compared to an 8 percent average reduction for LCC presence. They, also found that while ULCC and LCC entry both result in a 14 percent average reduction in fares one year after entry, ULCCs are three times more likely to abandon a market within two years of entry as compared to the LCCs.

Most airline pricing studies are concerned with the U.S. and Europe – the two largest aviation markets, and the two with the best publicly available data but there are very few papers explored the reaction of the market to the entry of LCCs in different countries from EU and U.S. Chen (2017) investigated the competitive responses of China Eastern to the entry of Spring Airlines into its hub airports in Shanghai. Spring put downward pressure on the average fares of China Eastern and other FSAs. China Eastern responded more aggressively to Spring's competition than competition from other FSAs on routes from the same and nearby airports. The moderate price reduction of 4 percent to 4.9 percent suggests that China Eastern did not perceive Spring as a serious competitor. Such limited impacts are due to restrictions imposed by the regulator on Spring Airlines in terms of capacity control and access to major trunk routes as well as undesirable slots which reduce Spring's competitiveness against China Eastern.

Valdes and Gillen (2018) utilized a data panel of domestic flights to/from Mexico City International Airport to estimate a structural model for air travel. The model provided parameter estimates of the impact of slot control, flight frequency, and market structure on airfares. The model is used to develop measures of consumer welfare changes with slot reallocation from a legacy carrier to two LCCs. They used G2SLS regression. The key results were frequency on balance leads to lower airfares; an increase in airline share, an indicator of route market power, increases airfares, and a decrease in slot concentration at the airport does not affect airfares.

There are occasional situations where the LCCs have not acted as a "Low Cost Carrier". Avogadro et al (2021) investigated the occurrence of situations where LCCs sometimes offer higher fares than FSCs on competing flights. They used the Multivariate Logistic Regression model, and as explanatory variables, they considered both flights' characteristics such as a month, day, and hour of departure, specific route characteristics such as degree of competition, departure/arrival airport distances, and population, and finally carriers' business scale and service level. One of the promising results of this paper is that the coefficient of the variable "days before departure" is statistically significant and negative, which implies an increase in the phenomenon when approaching the date of the flight. This might be directly attributed to the different practices of dynamic pricing, LCCs being less aggressive in the days close to the flight departure, in comparison with the more aggressive approach typical of FSCs.

Literature Summary

After U.S. deregulation, researchers analyzed the effect of entry of LCCs, into aviation markets on airfares and market structure, mostly focused on the EU or U.S. since data are publicly available. They explored the entry patterns and recognized the factors having an effect on LCCs' decision whether to enter or exit a route. There is limited research exploring the differences between ULCCs and LCCs entry. Also, few papers look into other countries aviation market such as Australia and China. Considering all the above-mentioned research, there is a lack of knowledge on the effect of entry of LCCs on the Canadian aviation market. Due to having access to the Canadian aviation data from 2014 to 2022 this research will be the first empirical work to examine on a granular level the effect of entry of LCCs and ULCCs on the airfares and market structure. There are many factors distinguishing Canada from U.S. or Europe such as geographical shape, population, GDP, number of cities and the dominance of a former government owned airline in most markets. Canada is one which is similar to the U.S. in terms of distance but lacks the population density

Chapter 3: Data Analysis

In this chapter, we identify the characteristics of the Canadian domestic aviation market, provide details about the dataset used in our empirical model and display more specifically its characteristics including market shares by carrier over time, average fares in the fare classes as well as distribution of passengers among fare classes and among airlines. We define the specific variables we use in the empirical model and provide a summary of their statistical characteristics. As mentioned in the previous chapter, there are many differences between the Canadian aviation market and the U.S. or EU. While Canada is home to roughly only 40m people (similar to California's population), it supports a dynamic airline industry which is boosted by not only its access to the large U.S. aviation market but also to some of the country's unique characteristics. It has a large number of immigrants, which drives volumes visiting family and friends, its cold weather conditions also help to generate high outbound winter leisure traffic to sunshine markets like Florida, Arizona, California and Hawaii. Canada's advanced economy also possesses a large natural resource sector which stimulates high rates of business travel. One of the most important factors distinguishing Canada from the U.S. and the EU is the number of trunk routes, which is limited only to the routes between the following cities: Vancouver, Montreal, Quebec, Toronto, Ottawa, Winnipeg, Calgary, Edmonton, and Halifax; Canada has a long thin domestic market running west- east reflecting the fact that the majority of Canadians live within 350 km of the US border.

To model the effect of entry by LCCs on the market structure and on air fares, the explanatory variables were chosen from past literature and can be broadly classified into two categories (Boguslaski et al., 2004): market features (Distance and fare) and geographic and socio-economic features (Population and GDP). In this chapter, we examine in detail the Canadian scheduled commercial flights' dataset available from 2014 to the end of 2019 (before Covid-19 pandemic).[12] The dataset is available monthly for domestic routes for all fare classes and revenue passengers by carrier in Canada.[13] Definitions of the variables used in the dataset are as follows:

Total Passengers is the total number of revenue passengers on each route for each month.

Miles is the great circle distance from the trip origin to the trip destination.

Travel Month is the dummy variable taking the value D1 if the months of June, July and August, and D0 otherwise. We consider Travel Month as a dummy variable to control the effect of summer seasonality on airfares and number of passengers.

STOP is a dummy variable set equal to D1 if the flight has one stop, D2 for more than one stops and D0 if the flight is non-stop. To some extent this variable indicates the level of service quality, more stops indicate less service quality while more flights in total in a city-pair market reflects a higher service quality.

HHI is the Hirschman-Herfindahl Index of seller concentration, defined as the sum of squared market shares (measured by passengers) of airlines on a route.

Population is the of population of each city in a city pair market.

GDP is the annual GDP of the provinces origins and destinations are located in.

Fare is the price of the ticket in USD.

FPM is the fare in US Dollars per revenue-passenger mile.[14]

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[12] The data was available from 2014 through to September 2022, however, due to the impact of government restrictions during the pandemic and because of the grounding of the Boeing 737MAX for an extended period which significantly impacted the fleets of both Air Canada and WestJet, the data used extended only to 2019.

[13] The Canadian data is not as 'transparent' as the U.S. data where the latter is based on a 10 percent ticket sample. The data used here has a time dimension of one month, meaning, the fare on a route is the average of fares for an airline for a route for a month. Passenger data is recorded in the same way.

[14] All values are reported at trip-level granularity. Passenger and Revenue figures in each market are per period and directional. Fare and Revenue figures in each market reflect the System Fare and Revenue values, including connecting flights.

Airline is a dummy variable indicating the name of the airline. The operating airline is distinguished from the marketing airline.

Emergence LCC, is a dummy variable taking the value of D1 after Sep 2017 until June of 2018 which indicates the effect of entry of Flair into a city-pair market and taking the value of D2 after June 2018 because of Swoop's entry and also taking D0 otherwise. This variable helps to distinguish the effect of an LCC(Swoop) and ULCC (Flair) entry into an aviation market and compare them with one another.

To simplify and keep manageable the data in our modeling we considered only the six largest scheduled airlines operating in Canada[15] during the dataset time period. These six accounted for the vast majority of traffic on the city-pair routes included in the data.

To better understand the dataset, we look into the details of the data and display the variables' characteristics used in the panel data analysis for illustrating the demand and air fares trend in the Canadian aviation market. The demand and air fares distribution for three different fare classes are shown in table 1:

Table 1: Distribution for Three Different Fare Classes

Fare class	**Average number of monthly passengers for each route**	**Average Fare Per Route Mile**
Economy	156	0.2212
Premium Economy	82	0.2698
Business	31	0.4727

The above table shows there is a considerable difference between FPM (fare per mile) of Business and Economy/Premium Economy, while the difference between the Economy and Premium Economy is negligible. For the sake of simplicity, in this research we considered only

[15] Air Canada, WestJet, Swoop, Flair, Sunwing, Porter

Economy class, as from the literature we know that entry of LCC/ULCCs do not significantly affect fare classes other than economy class.

Passengers choosing among competing carriers on a route would not only consider the fare but also the reach of the carrier – how many destinations they fly to. The demand for air travel is not distributed similarly among carriers (two carriers control 95 percent of the domestic market); the share of each airline, considered in this research, in the Canadian market across all routes in the dataset is shown in Table 2:

Table 2: Market Share by Carrier for Canadian Domestic Market

Airline	Percentage of Market Share
Air Canada (AC)	61.773%
WestJet (WS)	33.493%
Porter (PD)	2.279%
Flair (F8)	1.774%
Swoop (WO)	0.376%
Sunwing (WG)	0.306%

As Table 2 shows, FSCs have a significant percentage of market share, and Air Canada has almost twice market share as WestJet which is its only FSC competitor. Figure 1 illustrated more specifically the demand trend of FSCs over the time period of the dataset. As discussed in the previous chapter, Flair made its debut in the market in 2017, while Swoop arrived in 2018. The substantial decrease in the total number of passengers for WestJet following 2018 is attributed to the introduction of Swoop. It is clear that WestJet transferred many of its operational routes to Swoop, and the two airlines do not compete with each other (as Swoop is an AWA). Notably, the plot also reveals that Air Canada did not experience a significant shift in market share after the entry of Flair and Swoop.

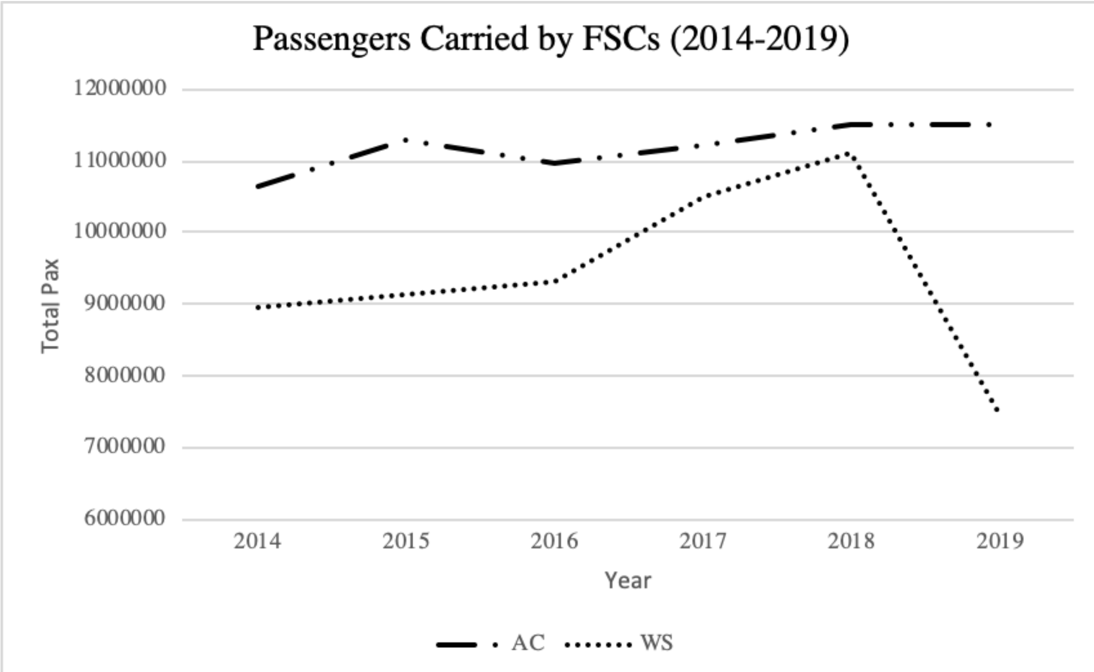

Figure 1: Passengers Carried by FSCs (2014-2019)

As the demand for (Full Service Carriers) FSCs is much higher than for LCCs, a separate plot of LCCs and ULCC is shown below.

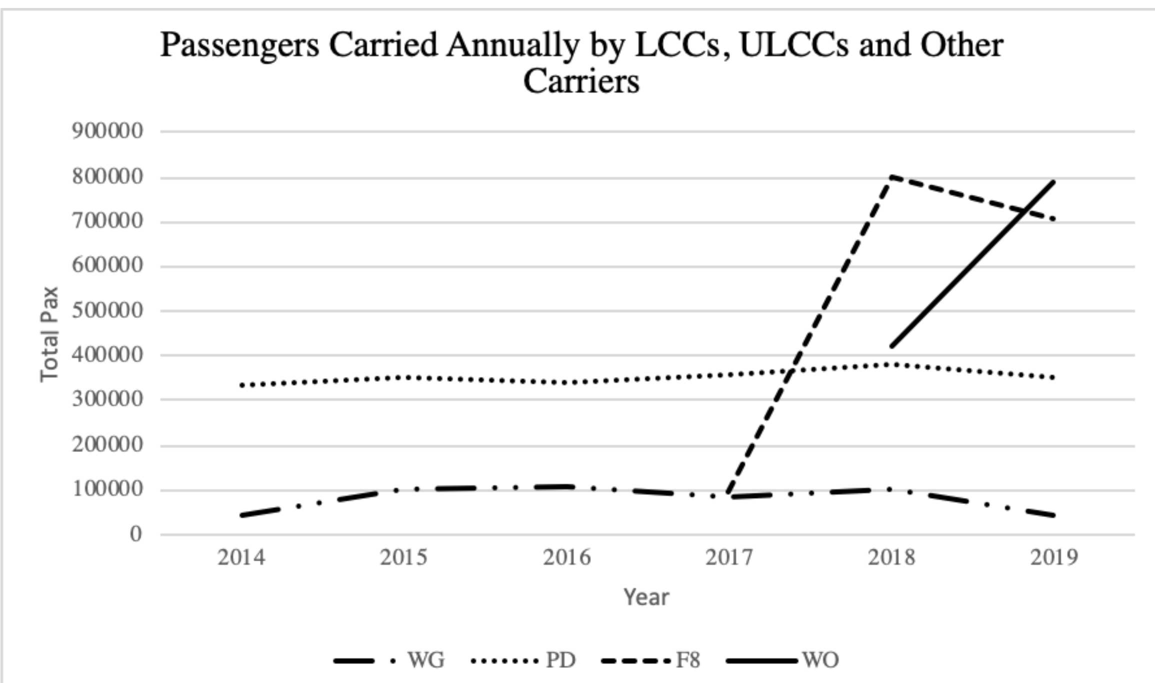

Figure 2: Passengers Carried Annually by LCCs, ULCCs and Other Carriers

As evident in Figure 2, it the demand for Flair's service significantly increased upon its entry into the market. However, with the entry of Swoop into the market, Flair's demand started to decline. Despite differences in their services, they are considered competitors because they have a similar target market. The rise of Swoop in 2019 can be seen as offsetting the decrease in WestJet's flights, shown in a previous plot but also both Flair and Swoop expanded the market by attracting passengers from other modes and other activities.

Not only the demand trend helps us in our further investigations but also the trend of FPM over time could lead us to a better insight into the Canadian aviation market. In Figure 3, we are observing a significant decrease in the total passengers carried in 2019. This has two explanations, first, as evident in Figure 4 there was a significant increase in the fare per mile after 2018. However, also this was also when the grounding of the Boeing 737 Max occurred. Two Canadian airlines, Air Canada and WestJet, operated Boeing 737 Max planes before the grounding in 2019. Air Canada had 24 Boeing 737 Max planes in its fleet, while WestJet had 13. Following the grounding, both airlines had to cancel flights and make alternative arrangements for passengers. The Boeing 737 Max planes were only allowed to fly again in Canada after they received regulatory approval from Transport Canada in January 2021. This observation would help us in next chapters when we want to identify the relationship between air fares and total number of passengers.

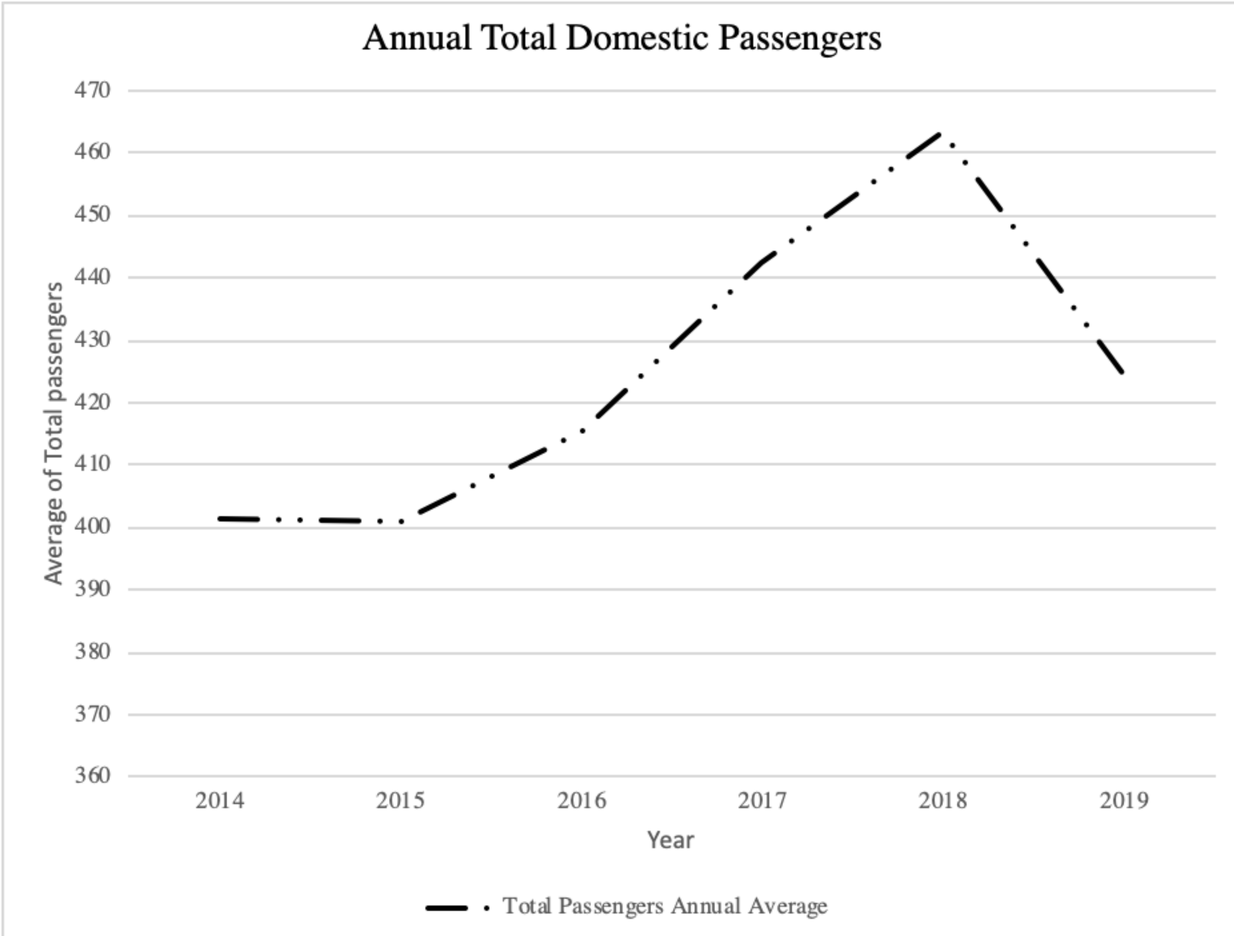

Figure 3: Annual Total Domestic Passengers 2014-2019

As we see a huge decline in number of total passengers in 2019 caused FPM of that year to rise up sharply.

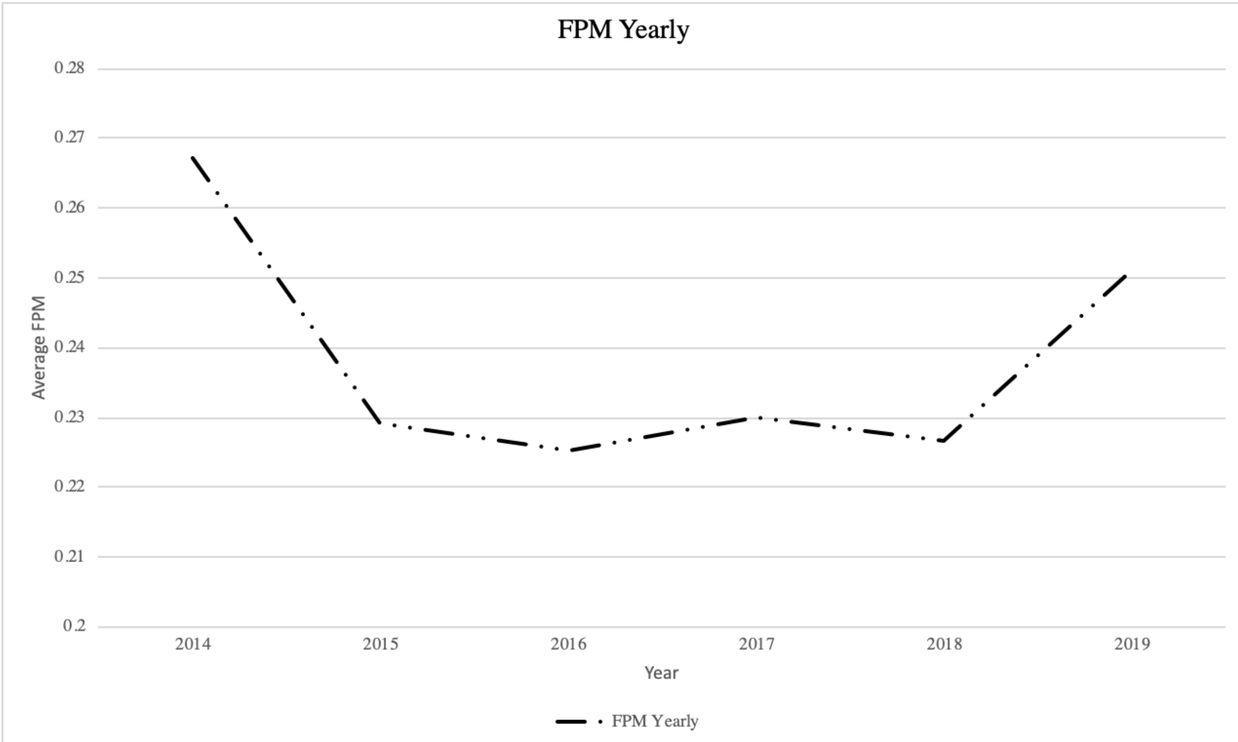

Figure 4: Annual Average Fare per Mile Across all Carriers and All Routes 2014 - 2019

As previously noted, we anticipate that external factors will influence the demand for air travel, such as the travel month. Certain months may alter demand and subsequently affect airfares. This pattern is depicted in Figure 5.

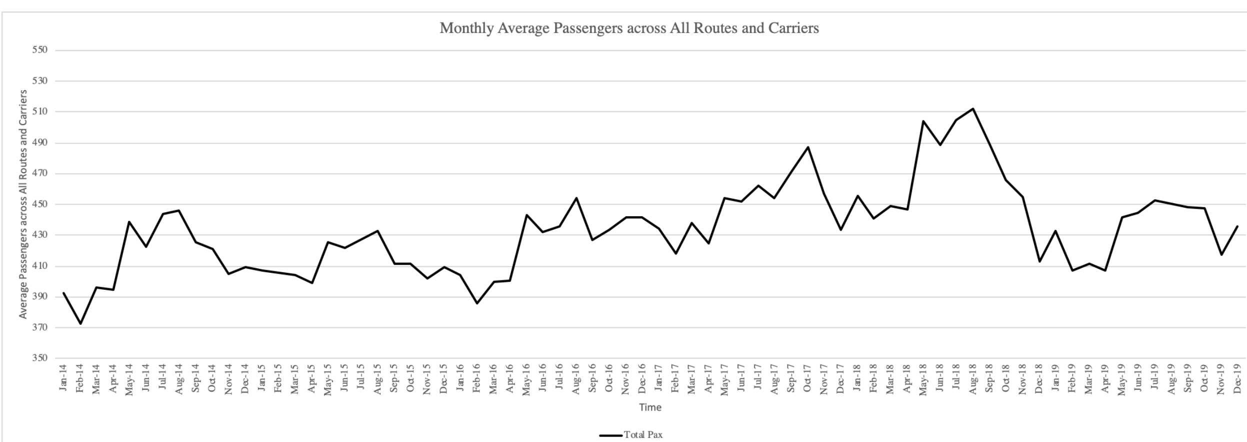

Figure 5: Monthly Average Passengers across All Routes and Carriers 2014-2019

There are small increases in January and small decreases in December and large increases in the summer months. Airfares can fluctuate throughout the year based on a variety of factors such as seasonality. The factors mentioned below are possible justifications for higher airfares in summer.

High Demand: During the summer, many people take vacations, especially families with children who are out of school. This leads to increased demand for flights, which can drive up prices

Limited Supply: Airlines often reduce the number of flights during the off-peak season, and then increase the number of flights during the summer to meet the higher demand. However, this increase in supply may not be enough to keep up with the increased demand, leading to higher prices.

Seasonal Routes: Some airlines may operate seasonal routes that are only available during the summer, such as flights to popular vacation destinations. These routes may have higher fares due to limited availability and high demand.

Overall, the combination of increased demand, limited supply, and possibly higher operating costs can lead to higher airfares during the summer months.

There is a well-established literature in industrial organization, and certainly for the aviation industry, that market structure has an impact on prices and service quality offered in markets. The HHI variable which takes account of the number and size distribution of firms (airlines) in each market is a metric of market structure. When a new firm, such as Flair or Swoop, enters a market the market structure changes, competition should increase, and we expect that airfares and service quality will change as a consequence. Heightened competition would result in a decrease in airfares, an increase in the number of services and have an increase in passenger traffic. This is because, in the presence of competitors, particularly with a variety of business models, airlines will present a range of fares and service offering, which is akin to an increase in product variety. Again, it is well established in the industrial organization literature that product variety is welfare enhancing largely because variety will increase price dispersion and an airline may have a product offering which is closer to the most preferred product of a passenger or potential passenger. Therefore, when multiple airlines are operating on a given route, it is probable that a wider range of individuals will choose to travel because average fares will be lower, fare dispersion will be higher and product variety will be higher.

Figure 6 and 7 below depict the difference between the FPM of non-competitive and competitive routes for four airlines. When interpreting these plots, we should pay attention to the number of passengers travelling with each airline. As the plots are illustrating FPM will decrease when there is competition. An explicit example is Air Canada, which increase it fares significantly in the absence of competition. Also, when there is competition on a route Flair would decrease its prices significantly to grow its market share.

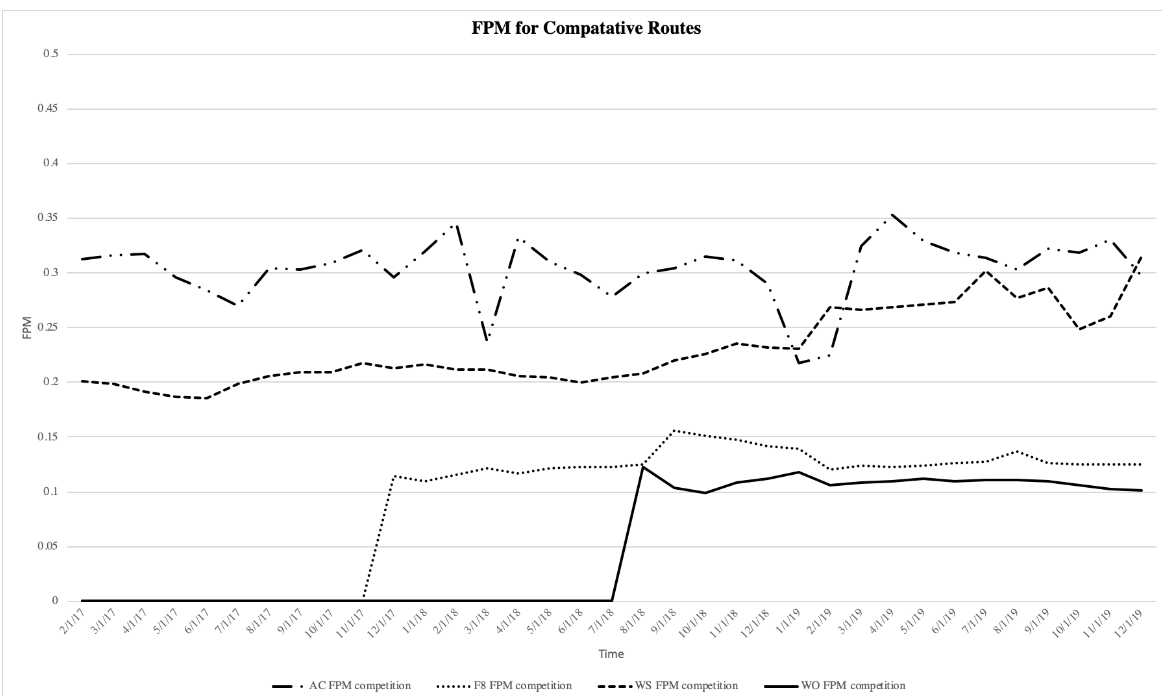

Figure 6: Monthly Average Fare per Mile on Routes for Competitive Routes

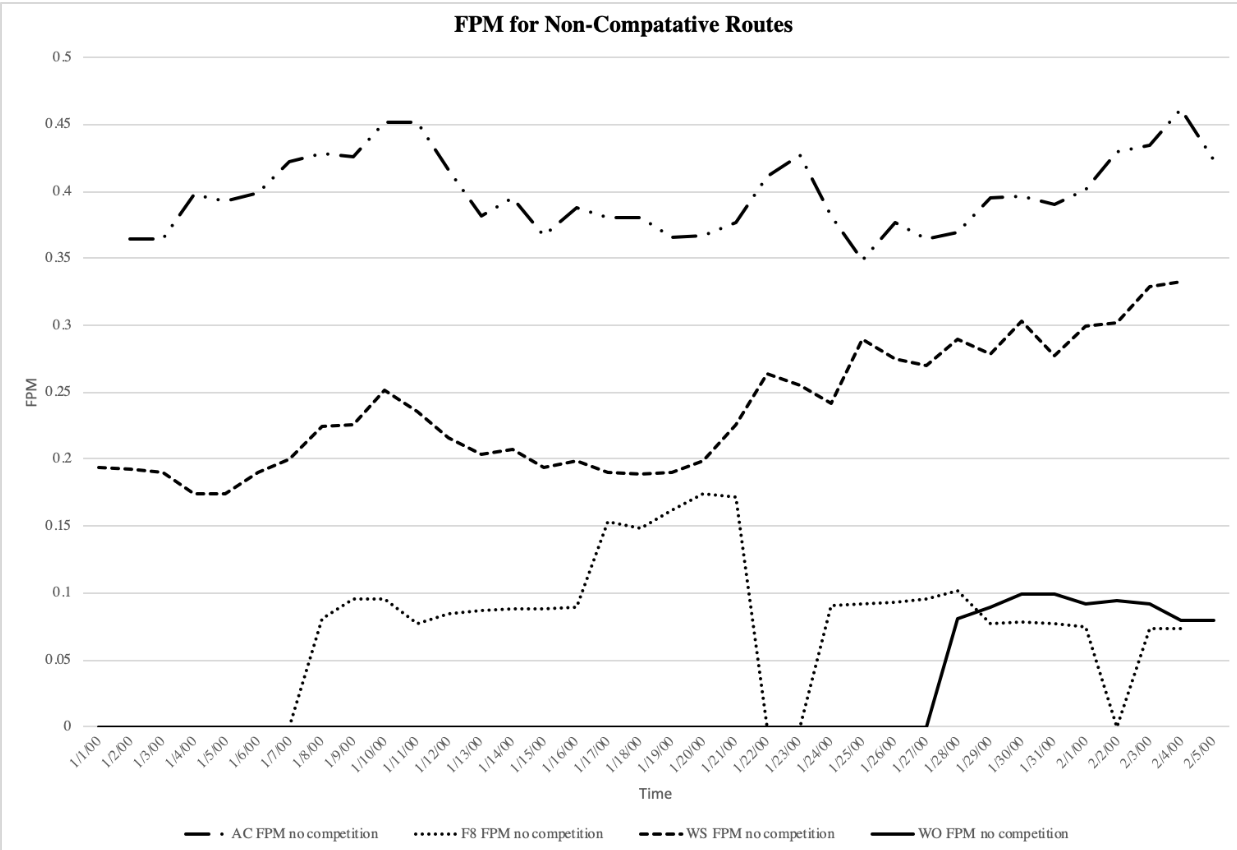

Figure 7: Monthly Average Fare per Mile on Routes for Non-Competitive Routes

Descriptive Statistics

Descriptive statistics are valuable for summarizing and analyzing the features of a dataset. It allows us to gain insight into the central tendencies and distribution of the data by utilizing measures such as mean, median, mode, standard deviation, variance, and range. However, it is important to carefully select the variables to be analyzed based on a clear and justifiable rationale, ensuring that the descriptive statistics accurately reflect the most relevant features of the dataset. Few of the numeric variables' descriptive statistics are shown below in table 3.

Table 3: Descriptive Statistics (All Routes)

	Min	Median	Mean	Max	Skewness
Total Passengers	10.00	52.92	424.94	62099.62	10.79
Fare	1.03	207.19	214.42	1379.54	1.09
Miles	23	1087	1276	3223	0.34
HHI	832.81	1238.11	1252.91	1676.92	0.12
LOGproductpop	6.20	10.93	10.90	13.41	-0.22

Descriptive Statistics (Short-haul Routes: Less than 800 Miles)

	Min	Median	Mean	Max	Skewness
Total Passengers	10.00	65.55	547.63	35818.96	7.12
Fare	1.03	158.55	164.11	999.71	1.60
Miles	23	542	598.1	1195	0.33
HHI	832.81	1225.6	1238.9	1676.92	0.14
LOGproductpop	6.20	10.71	10.68	13.41	-0.30

Descriptive Statistics (Long-haul Routes: More than 800 Miles)

	Min	Median	Mean	Max	Skewness
Total Passengers	10.00	41.01	585.85	62099.62	15.82
Fare	83.28	259.73	271.53	1323.31	2.3
Miles	23	542	598.1	1195	0.33
HHI	832.81	1233.6	1251.3	1676.92	0.11
LOGproductpop	7.87	11.15	11.16	13.20	-0.08

Chapter 4: Theoretical Model

In this chapter, we present the composition of the regression model to explain the total number of passengers and airfares. We also check several assumptions that we should pay attention to when running an econometric regression model to ensure that the results are valid and reliable. These assumptions include: Linearity, Normality of residuals, Homoscedasticity, Autocorrelation, Multicollinearity, Heteroscedasticity and Endogeneity. By examining the econometric tests and diagnostics, we can understand how well the regression models are performing and whether they need further tuning or adjustments. To ensure the reliability of our models, it is essential to address endogeneity, as indicated by the papers discussed in the literature review, Chapter 2. We conduct a concise literature review to identify the presence of endogeneity and determine the most suitable approach to handle it.

Gillen and Hazledine (2015) used 2SLS method to estimate their airfare model. They investigated if the number of competitors in a market (HHI) affects prices in a way that is not being captured by the model. Their main question was regarding the possibility that higher prices are causing more competitors to enter the market, which makes HHI endogenous and which could bias the OLS coefficients. They believed that this bias would result in the OLS coefficient on HHI being underestimated. The reason for this bias is that a market with unusually high demand and high prices would be attractive to competitors looking to make a profit. So, higher prices could actually increase competition, which would counteract the expected effect of more competitors leading to lower prices. However, there could be an opposite effect as well. To address this potential bias, Gillen and Hazledine proposed a solution. They suggested using the populations of the cities at each end of the route as instruments for HHI. They believed that these populations would strongly influence the amount of travel between the cities and create more opportunities for additional airlines to enter the market. When they used this instrument, the estimated coefficient on HHI increased by about 10 percent, but all the other coefficients remained largely unaffected. The t-statistic on HHI decreased, but the overall explanatory power of the model remained strong. Overall, Gillen and Hazledine concluded that they had good instruments for HHI in their model, but they did not need to use them. Therefore, they found no evidence of endogeneity being a problem in their analysis.

Homsombat et al. (2014) presented a regression model that showed how the concentration of routes could affect airline pricing and decisions to enter a market. Their study focused on the three major airlines in the Australian domestic market (Qantas, JetStar, and Virgin Australia), so using the RouteHHI measure could create issues with endogeneity when estimating fares and entry patterns. Even though they included RouteHHI in their study, they found that its inclusion didn't significantly alter the results of their estimations.

According to Ruowei Chen's (2017) study, flight frequency is measured by the number of scheduled departures in a month, and the logarithm form is also used. Higher flight frequency can result in fewer schedule delays and better service quality. Still, it can also lead to excess capacity and put downward pressure on airfares, which could offset any positive effects. Additionally, flight frequency might be endogenous because airlines may reduce airfares to attract more passengers as they plan more frequently. The study used panel data to address this issue and included one-month and three-month time-lagged frequency variables as instrumental variables. However, the results of the Durbin-Wu-Hausman test showed that the instrumental variable of frequency was not necessary, and thus this approach was not used in the study.

Dresner et al. (2021), found that the presence of Norwegian Airlines, the largest transatlantic low-cost carrier (LCC), on a particular route is linked to lower airfares, approximately 5 percent lower. This association holds even after accounting for other factors that may affect fares. When considering route characteristics and competition levels, Norwegian's presence is significantly correlated with lower fares compared to other routes. However, it is worth noting that the reduction in fares for long-haul routes in their dataset is not as pronounced as the impacts observed in previous studies that focused on shorter-haul routes.

Gillen and Valdes (2018) provided a regression model for passengers. GDP is considered an exogenous variable in their model, while airfare and passengers are jointly determined. The expected sign of airfare is negative, whereas for GDP, it is positive. The remaining right-hand side variables are controls, θ_is are random and time-invariant individual-specific effects and u_{it}s are idiosyncratic errors.

To estimate Air Travel Demand when endogeneity is present, they used a Generalized Two Stage Least Squares Instrumented Variable regression (G2SLS-IV) where the airfare reduced form equation is instrumented by flight frequency, LCC, airline share and LCC-share. In this way, they were “tracing” Air Travel Demand through shifts in supply. Although, they did not include flight frequency in Eq. (1) because it is almost perfectly correlated with passengers, its inclusion in the airfare reduced form equation produces an indirect effect on passengers. In other words, it is expected that an increase in flight frequency (quality of service from passengers’ perspective) increases passengers via a reduction in airfare. Therefore, Air Travel Demand can be considered as a quality-adjusted demand. A Hausman specification test for joint endogeneity was used to confirm if prices and quantities are jointly determined. A key assumption exists about the behavior of individual-specific effects in (1). Under the fixed-effects, individual effects are permitted to be correlated with the regressors, whereas in random effects, the individual-specific effects are purely random, implying that they are uncorrelated with regressors. Including time-invariant variables such as gdp, dis and tourist in (1) can be seen as individual fixed-effects out of θ_i, such that random-effects might be a plausible assumption. A formal test to choose between fixed or random effects can be used. The Hausman specification test has generally been used to test between the fixed and random effects models but has recently been shown to potentially have some biases (Sheytanova, 2014).

(1) $$passengers_{it}^{D} = \beta_0 + \beta_1 airfare_{it} + \beta_2 gdp_i + \beta_3 dis_i + \beta_4 tourist_i + \beta_5 jun_t + \beta_6 jul_t + \beta_7 aug_t + \beta_8 sep_t + \beta_9 oct_t + \beta_{10} nov_t + \vartheta_i + u_{it}$$

(2) $$airfare_{it} = \alpha_0 + \alpha_1 flightfreq_{it} + \alpha_2 airlineshare_{it} + \alpha_3 lccshare_{it} + \alpha_4 lcc_i + \alpha_5 dis_i + \alpha_6 jun_t + \alpha_7 jul_t + \alpha_8 aug_t + \alpha_9 sep_t + \alpha_{10} oct_t + \alpha_{11} nov_t + \rho_i + \mu_{it}$$

After reviewing the aforementioned literature, we should check the possibility of endogeneity in the independent variables of the regression model, if the endogeneity is identified, there are several methods we can use to fix the regression model:

- **Instrumental Variables (IV) Regression:** This method involves finding an instrumental variable that is correlated with the endogenous variable but not with the error term. The instrumental variable is then used to obtain unbiased and consistent estimates of the coefficients. Two-Stage Least Squares (2SLS) is one of the methods of using IVs in regression that involves two stages. In the first stage, the endogenous variable is regressed on the instrumental variable to obtain predicted values of the endogenous variable. In the second stage, the predicted values of the endogenous variable are used as the explanatory variable in the main regression equation.

- **Control Function Approach:** This method involves including additional variables in the regression equation that capture the correlation between the endogenous variable and the error term. These additional variables are called control variables and are used to obtain unbiased and consistent estimates of the coefficients.
- **Fixed Effects Regression**: This method involves including fixed effects for each individual or group in the regression equation. Fixed effects can capture unobserved heterogeneity and help to control for endogeneity.
- **Difference-in-Differences (DID):** This method involves comparing changes in the outcome variable for a treatment group and a control group before and after a treatment is introduced. By comparing these changes, you can control for unobserved heterogeneity and endogeneity.

The choice of method depends on the specific context and the availability of data. It is important to carefully consider the assumptions underlying each method and to test the validity of these assumptions. From the above literature, we concluded that for the airfare regression model there is the possibility of endogeneity of passengers and HHI. Higher fares in the market could attract more airlines to that market and also higher fares can decrease the number of passengers on that route. In order to check that assumption in our dataset we used Hausman test. The test is used to compare the efficiency of two estimators: one that assumes endogeneity (e.g., ordinary least squares, OLS) and another that corrects for endogeneity (e.g., instrumental variables, IV). If the test suggests that the endogenous variable is correlated with the error term, we can conclude that there is endogeneity. The Hausman test should that there is endogeneity both for HHI and Total Passengers. The literature offers some options for IVs to fix this endogeneity. For fixing the possible endogeneity of HHI, we chose log of product of population of origins and destinations as an IV, also for passengers we chose Distance (Miles) as an IV. Then we put the predicted values in the regression model. We tested the validity of IVs. It is also worth mentioning that we tried many IVs such as GDP instead of population to fix the endogeneity of HHI, and chose the ones which were giving out better results.

$$Predicted\ HHI\ = \gamma_1 Log(originpop * destpop) +\ \varepsilon$$

$$Predicted\ Passengers\ = \alpha_1 Miles + \delta$$

$$Fare = \beta_0\ + \beta_1 Log(Predicted\ HHI) + \beta_2 Log(Predicted\ Passengers) + \sum \beta_i DMAC_i +$$
$$\beta_8 Stops1 + \beta_9 Stops0 + \beta_{10} Month2 + \beta_{11} LCC2 + \beta_{12} LCC1 + \beta_{13}\ ln(Miles) + \epsilon$$

$$i = PD, WS, AC, F8, WO$$

The airfares can rise when there are more passengers due to the principles of supply and demand. When demand for flights increases and supply stays constant, the price of flights will typically rise, this is because airlines have a limited number of seats available on each flight, and they want to maximize their flight revenue.

As more passengers try to book flights, the number of available seats on a flight decreases, this can cause the price of each remaining seat to increase as airlines try to balance the number of passengers with the number of available seats but still seeking to maximize flight revenue. Additionally, airlines may also adjust their prices based on the time of year or day, the popularity of the destination, and other factors that can be affected by demand. Furthermore, with more passengers comes more demand for services such as luggage handling, check-in, and airport space may need to be expanded to accommodate the increased number of passengers, which can lead to higher operating costs for airlines. To cover these costs, airlines may increase ticket prices. In summary, the fare can rise when there are more passengers due to the laws of supply and demand, the limited number of available seats on each flight, and the increased demand for services that come with more passengers.

It is worth mentioning that taking the logarithm of some variables in a linear regression model can provide several benefits, including:

Handling skewed data: If the data is skewed, taking the logarithm of the variable can help normalize the data, making it more symmetric and easier to model. This can improve the accuracy of the linear regression model.

Linearizing relationships: In some cases, the relationship between the independent and dependent variables may not be linear. Taking the logarithm of one or more variables can transform the relationship into a more linear form, making it easier to model using linear regression.

Interpreting coefficients as elasticities: When you take the logarithm of a variable, the coefficient on that variable in the log-linear regression model represents the percentage change in the dependent variable associated with a one percent change in the independent variable. This makes it easier to interpret the coefficients as elasticities or proportional changes, which can be useful in certain applications.

Managing outliers: Taking the logarithm of variables can help to manage the impact of outliers in the data. Outliers can have a disproportionate effect on the linear regression model, but taking the logarithm of the variables can mitigate this effect. Overall, taking the logarithm of some variables in a linear regression model can help to improve the accuracy of the model and make it easier to interpret the results. However, it is important to carefully consider whether taking the logarithm of variables is appropriate for your specific data and research question.

Passengers:

The next variable we want to model is the total number of passengers on each route, grouped by their airline code. Based on the information we gathered from the literature review, the regression model proposed is:

$$\sqrt{\text{Total Passengers}} = \gamma_0 + \gamma_1 \text{FPM} + \gamma_2 \ln(\text{GDP}_\text{O} \text{ x } \text{GDP}_\text{D}) + \sum \gamma_i \text{DMAC}_\text{i} + \gamma_8(\text{Stops1}) + \gamma_9(\text{Stops0}) + \gamma_{10}(\text{LCC2}) + \gamma_{11}(\text{LCC1}) + \gamma_{12}\text{Month2} + \epsilon$$

i=PD, WS, AC, F8, WO

In regression models, it may sometimes be better to use the squared root transformation of a variable instead of its logarithmic transformation. The choice between these two transformations depends on the relationship between the independent variable (predictor) and the dependent variable (response) in the data being analyzed. Logarithmic transformation is often used when the relationship between the predictor and the response is multiplicative. In other words, a constant percentage change in the predictor corresponds to a constant percentage change in the response. In this case, taking the logarithm of the predictor can linearize the relationship between the predictor and the response, making it easier to model using linear regression. The square root transformation is particularly useful when the relationship is nonlinear but more curved at smaller values of the predictor, and becomes more linear at larger values. Moreover, square root transformation preserves the scale of measurement of the original variable, whereas logarithmic transformation changes the scale. This can be important in some cases where preserving the original units of measurement is necessary for interpretation or practical purposes.

The reasons mentioned above lead us to choose squared route of passengers instead of its logarithm.

The selection of variables was based on relevant literature and a logical assumption that higher airfares lead to decreased willingness to travel. Additionally, we believed that the GDP of both origin and destination could serve as a good indicator of people's income[16], and that different airlines would capture varying numbers of passengers. External factors, such as high travel season in the summer, could also impact air travel demand. Finally, we seek to determine whether the emergence of LCCs and ULCCs (Swoop and Flair) has affected air travel demand, and to what extent. We do not have enough solid reasons to suspect endogeneity among these variables in the regression model, and no literature review has raised concerns about their endogeneity with passengers. In the next chapter, we will apply our models to the dataset and provide further details and justifications for our variable choices, additionally, we calculate the price elasticity of demand to gain clarity on how the demand for air travel in Canada would respond to changes in airfares.

[16] GDP is the only variable in the questions which is collected on a yearly basis rather than a monthly basis.

Chapter 5: Model Implementation

As discussed in the previous chapter, the main interests in this thesis are to measure the responsiveness of Canadian passengers to changes in fares, second, to examine whether there is a difference in the impact on fares when a LCC (Swoop) enters a market versus when an ULCC (Flair) enters and lastly, to search out the factors having an effect on airfares and demand in the Canadian aviation market. There have been numerous empirical models of demand elasticity estimates made for the aviation sector over the past three decades; see for example, the discussion in Gillen, Morrison and Stewart (2003) and InterVistas (2007).[17] The majority of the studies used aggregate data and estimated elasticities for a country. Initially, only the U.S. provided detailed data by route and airline that permitted researchers to estimate more granular elasticity estimates for short and long-haul routes and domestic versus international routes. Subsequently, the EU, Australia, and the UK have provided more detailed aviation data. Estimates for Canada have been based on data pre-1984; in 1984 Canada deregulated its airline industry and from that point forward released almost no data except at such an aggregate level as to make it unusable.

The juxtaposition of the differences of the impact of LCC entry versus ULCC route entry is based mostly on anecdote and case studies. After U.S. domestic airline deregulation in 1978, there was a period of disequilibrium in which the industry observed various, and numerous, entries and exists by LCCs and/or carriers offering limited point to point service. The airline that held the attention of researchers was Southwest, a low-cost carrier that charged low fares and had a simple

[17] Gillen, D.W., Morrison, W.G. and Stewart, C. (2003) Air Travel Demand Elasticities: Concepts, Issues and Measurement. Department of Finance, Government of Canada and Estimating Air Travel Demand Elasticities, InterVistas (study undertaken for IATA), 2007.

business model, simple fare structure and simple organizational and network structure. As more academic research was undertaken (see, for example, Morrison and Winston, 1995; Morrison (2001) and Dresner et al. (1996),[18] there was clear empirical evidence that when a LCC entered a route, fares fell, in some cases significantly and for considerable periods before they would recover, in some cases, 70-80 percent of their pre-entry level. It was also evident that which LCC was entering would have a different impact on how far fares might decrease. In 2007, the ULCC (Ultra Low-Cost Carrier) model entered the U.S. market and subsequently proliferated in airline markets in the U.S., Europe and Southeast Asia. The differential impact of LCCs and ULCCs on U.S. markets was first undertaken in 2017 by Bachwich and Wittman.[19] They find that entry by a ULCC results in a 21 percent reduction in base fares which is considerably higher than the 8 percent reduction characterizing entry by a LCC. Interestingly, after one year, fares for both types of carriers are similar in that base fares rise to 14 percent lower than pre-entry fares. They also find ULCCs are three times more likely to abandon a market that they have entered within two years.

In this chapter, we apply our regression model for airfare and passengers to a dataset covering Canadian domestic flights from 2014-2018, specifically focusing on the six primary scheduled passenger airlines operating in Canada. The outcome for airfare regression model is presented below. The specification is:

(1) $Fare = \beta_0 + \beta_1 Log(Predicted\ HHI) + \beta_1 Log(Predicted\ Passengers) + \sum \beta_i DMAC_i + \beta_6 Stops1 + \beta_7 Stops0 + \beta_8 Month2 + \beta_9 LCC2 + \beta_{10} LCC1 + \beta_{11}\ ln(Miles) + \epsilon$

[18] Steve Morrison and Clifford Winston, *The Evolution of the Airline Industry*, Brookings Institution, 1995; Steven Morrison (1996), Actual, Adjacent and Potential Competition: Estimating the Full Effects of Southwest Airlines, *Journal of Transport Economics & Policy*, Vol. 35, Issue 2, 239-256 and, Martin Dresener, Jiun-Sheng Chris Lin and Robert Windle (1996), The Impact of Low-Cost Carriers on Airport and Route Competition, *Journal of Transport Economics & Policy*, Vol. 30, No. 3, 309-328.

[19] See Alexander Bachwich and Michael Wittman (2017), The Emergence and the Effects of Ultra-Low-Cost Carrier Business Model on the U.S. Airline Industry, Journal of Air Transport Management, Vol. 62, July, 155-164.

$$i = PD, WS, AC, F8, WO$$

Predicted Passengers is predicted total number of revenue passengers on each route for each month.

Miles is the great circle distance from the trip origin to the trip destination.

Travel Month is the dummy variable taking the value D1 if the months of June, July and August, and D0 otherwise. We consider Travel Month as a dummy variable to control the effect of summer seasonality on airfares and number of passengers.

STOP is a dummy variable set equal to D1 if the flight has one stop, D2 for more than one stops and D0 if the flight is non-stop. To some extent this variable indicates the level of service quality, more stops indicate less service quality while more flights in total in a city-pair market reflects a higher service quality.

Predicted HHI is the predicted Hirschman-Herfindahl Index of seller concentration.

Population is the of population of each city in a city pair market.

GDP is the annual GDP of the provinces origins and destinations are located in.

Fare is the price of the ticket in USD.

Airline is a dummy variable indicating the name of the airline. The operating airline is distinguished from the marketing airline.

LCC, is a dummy variable taking the value of D1 after Sep 2017 until June of 2018 which indicates the effect of entry of Flair into a city-pair market and taking the value of D2 after June 2018 because of Swoop's entry and also taking D0 otherwise. This variable helps to distinguish the effect of an LCC(Swoop) and ULCC (Flair) entry into an aviation market and compare them with one another.

The results are contained in Table 5.1. The results are consistent with previous literature. Log(HHI) has a positive sign indicating that more concentrated markets result in higher fares. We were not able to distinguish the differences in the mix of business models (hub-and-spoke carrier, LCC and ULCC) participating in the market due to fewness of markets. Therefore, the HHI variable is picking up both the number and size distribution of firms but also the mix of business models. With fewness of firms, passengers have fewer substitutes and their demand elasticities would be lower for any given airline and airlines can exploit this feature. In the case in which there is a significant difference in size distribution among carriers with a dominant carrier, we are likely to see a leader-follower relationship. This relationship would be tempered somewhat if the leader was a hub-and-spoke airline and the follower a LCC or ULCC.

A lack of competition in a concentrated market can lead to higher fares for passengers, as airlines have more pricing power and can charge more for their service; in situations where Air Canada is the sole carrier on a route, it charges significantly higher fares compared to when it shares the route with other carriers. It does matter who the carriers are that participate in the market. In this regard, the airline specific dummy variables are revealing and the results align with our expectations.[20] Air Canada flights have consistently higher fares than other airlines, while Flair, an ultra-low-cost carrier, tends to offer greater fare reductions than its competitors. Swoop, a low-cost carrier, also charges lower fares than Air Canada or WestJet, although not to the same extent as Flair. Therefore, we can see that the presence of an ULCC in a market should lead to lower fares than if only a LCC was present. This is consistent with the evidence of Bachwich and Wittman (2017).

[20] Note the variable identifies the marketing carrier not the operating carrier because the marketing carrier sets the fares and service level. Both carriers are identified in the data.

The remaining variables are also consistent with our prior expectations. The forecasted passenger value (Predicted Passengers) variable has a negative sign, suggesting that larger markets tend to have lower fares. This can result from more seats being offered in the market, especially through more frequent service that allows airlines to realize some density economies, or from more airlines participating in those markets, thereby enhancing competition.

Table 4: Estimation Results for Fare Equation

Variable	Coefficient	Std. Error	t-Value
Intercept	-219700.0	2225.0	98.71
Log Predicted HHI	30820.0	312.2	98.72
Predicted Passengers	-0.1956	1766.0	-110.75
Dominant Marketing Airline Code PD	2.7390	2.0880	1.31
Dominant Marketing Airline Code WS	14.7600	1.9700	7.49
Dominant Marketing Airline Code AC	63.5400	1.9670	32.30
Dominant Marketing Airline Code F8	-20.4200	2.5440	-8.03
Dominant Marketing Airline Code WO	-10.1300	5.1010	-1.98
Stops1	11.1900	0.0329	34.02
Stops0	2.4190	0.4821	5.02
Month2	4.4360	0.2461	18.03
Emergence LCC2	-1.38400	0.0312	-44.27
Emergence LCC1	-8.7250	0.3401	-25.65
Log Miles	38.6800	0.4061	95.25
Adjusted R-Squared	**0.61**		
F-Statistic	30990		
Degrees Freedom	254506		

The existence and number of stops can be an indicator of the quality of service. Previous literature finds non-stop flights carry a premium relative to 1 or more stop flights. Also, that passengers with more inelastic demands (or higher yield passengers) tend to have a preference for non-stops. As we have previously noted, we anticipated that external factors, such as heightened demand for travel during the summer months, may influence airfares. Our results have confirmed our initial hypothesis, with the dummy variable month2 (representing June, July, and August) displaying a positive sign.

The variable names "Emergence LCC0" and "Emergence LCC1" represent the periods before and after the introduction of Flair. "Emergence LCC2" measures the impact of Swoop's entry into the Canadian aviation industry, when Flair is already in the market. Notably, Flair's entry appears to have a more significant influence than Swoop's on reducing airfares in the market.

The last variable is Miles, a measure of the length of a Route, higher miles typically lead to higher airfares for flight tickets because airlines base their pricing on a variety of factors, including the distance of the flight and the cost of providing the service. The more miles a flight covers, the more fuel and other resources the airline needs to allocate to the flight, which can drive up the cost of the ticket. In previous literature, flight distance has been used as a proxy for costs.

The Adjusted R^2 is near 60 percent which is a strong result given the significant amount of data we have with over 254,000 observations.

As most of the variables are showing a statistically significant effect, we decided to test for multicollinearity. This can be done using methods such as correlation matrices, variance inflation factors (VIFs), or eigenvalues. If multicollinearity is detected, there are several strategies that can be used to address it, such as removing one of the highly-correlated variables, combining the variables into a composite variable, or using principal component analysis (PCA) to reduce the dimensionality of the data. Alternatively, it is also possible that all the variables are truly significant and contribute meaningfully to the prediction of the dependent variable. In this case, it is important to carefully examine the regression coefficients and the sizes of the coefficients to determine the relative importance of each variable in the model.

To test for multicollinearity, we used the variance inflation factors (**VIFs**) method, the result is shown below in Table 5:

Table 5: Results of Variance Inflation Factor Test for Multicollinearity

Variables	**GVIG**	**DF**	**(GVIF^((1/(2*DF)))**
Predicted HHI	1.203323	1	1.096961
Predicted Passengers	1.392432	1	1.180013
Dominant Marketing Airline Code	1.095712	5	1.009182
Stops	1.423556	2	1.092304
Month	1.062077	2	1.015171
Emergence LCC	1.072784	2	1.017719

The column "(GVIF^((1/(2*DF)))" in the VIF table shows the square root of the Generalized Variance Inflation Factor (GVIF) raised to the power of 1 divided by twice the degrees of freedom (Df). This value is a modified version of the VIF that helps in interpreting the severity of multicollinearity. The GVIF^(1/(2*Df)) value provides an indication of the level of inflation in the variance of the estimated regression coefficient due to multicollinearity. The value interpretation is given in below:

Values close to 1: If the GVIF^(1/(2*Df)) value is close to 1, it suggests that there is minimal to zero multicollinearity associated with the corresponding predictor variable. In other words, the variable has little correlation with other predictors, and its inclusion in the model does not substantially inflate the variance of the coefficient estimate.

Values greater than 2: If the GVIF^(1/(2*Df)) value is greater than 2, it indicates some degree of multicollinearity. The higher the value, the more severe the multicollinearity; values (5-10) indicate a stronger potential for collinearity among the predictors. This suggests that the variable is correlated with other predictors in the model, and its inclusion may result in inflated variance of the coefficient estimate.

Passenger Equation

The second equation in the two-equation model is represented by the regression model for passengers. The specification was:

$$(2) \qquad \sqrt{Total\ Passengers} = \gamma_0 + \gamma_1\, FPM + \gamma_2\, ln(GDP_O\ x\ GDP_D) + \sum \gamma_i DMAC_i + \gamma_8(Stops1) + \gamma_9(Stops0) + \gamma_{10}(LCC2) + \gamma_{11}(LCC1) + \gamma_{12} Month2 + \epsilon$$

$$i{=}PD,\ WS,\ AC,\ F8,\ WO$$

The estimation results are contained in Table 6. One of the central and most important results is the coefficient for the fare variable, measured as FPM (fare per mile), and shows fare has a negative effect on total passengers consistent with the literature and compatible with what we observed in the fare model.

The sign of the coefficients of dummy variables for different airlines suggests that Air Canada and WestJet are having a larger customer base. This could be due to the fact that they operate more flights compared to the other airlines and have more operating aircraft. On the other hand, Swoop's coefficient is notably high, likely due to the limited time period for which data is available (i.e., only one year). It is also worth noting that WestJet has transferred many of its routes to Swoop, which has helped the latter to attract a greater number of passengers at a faster pace than Flair. As we expected in summer there is more demand for air travel and this can be two sided. As not only are people more willing and able to travel in the summer months, but also, as mentioned in the airfare modelling section, the airlines provide more capacity by adding more flights and, in some cases, add some routes to their schedule (only for summer) which stimulates passenger demand due to an increase in accessibility.

The logarithm of the product of GDP of origin and destination of flights is a powerful variable for analyzing the relationship between socio-economic indicators and travel behavior. Specifically, the positive sign of this metric indicates a strong correlation between wealth and travel propensity, whether for leisure or business purposes. This correlation is particularly evident in industrial cities, where higher levels of economic activity and productivity tend to generate higher income per capita. As individuals become more affluent, they tend to have greater disposable income, which they can use to finance travel expenses. Moreover, those in high-income brackets often have more flexibility in their schedules, which allows them to travel more frequently for both leisure and business purposes.

"Emergence LCC1" is capturing the effect of entry of Flair and "Emergence LCC2" captures the entry of Swoop into the Canadian aviation market. The results are showing both airlines grew the market rather than stealing traffic from other carriers. They were able to capture passengers from other modes but most likely from other activities, something which has also been found for U.S. and European LCC carriers. Flair increased the demand more than Swoop. We found in examining the data that when Swoop was introduced there was a notable shift in passengers from WestJet to Swoop. There is evidence that Swoop did grow the market but not as much as would be implied by the coefficient on the Swoop 'emergence' variable.

Table 6: Estimation Results for Passenger Equation

Variable	Coefficient	Std. Error	t-Value
Intercept	-27.0068	0.5152	-52.42
FPM	-3.8619	0.1482	-26.07
Log(GDP_O*GDP_D)	1.9224	0.0302	63.57
Dominant Marketing Airline Code PD	8.3988	0.4313	19.48
Dominant Marketing Airline Code WS	12.3646	0.4067	30.40
Dominant Marketing Airline Code AC	11.5986	0.4063	28.55
Dominant Marketing Airline Code F8	7.1793	0.5255	13.66
Dominant Marketing Airline Code WO	25.5863	1.0539	24.28
Stops1	4.4026	0.0630	69.90
Stops0	40.4147	0.0892	453.16
Month2	0.9570	0.0508	18.84
Emergence LCC2	0.1417	0.0646	2.19
Emergence LCC1	0.4273	0.0703	6.08
Adjusted R-Squared	**0.54**		
F-Statistic	24450		
Degrees Freedom	254507		

The price elasticity of demand for airfares can be informative because it measures the responsiveness of demand to changes in price. This information is valuable for airlines and policymakers as it can help make decisions regarding pricing strategies, route planning, and capacity management.

For example, if an airline wants to increase its revenue, it can use the price elasticity of demand to determine whether it should increase or decrease its fares. If the elasticity is low, meaning that demand is not very sensitive to price changes, the airline may be able to increase fares without losing many customers. However, if the elasticity is high, the airline may need to lower fares to avoid losing a significant number of customers.

Similarly, policymakers can use the price elasticity of demand to design policies that encourage or discourage air travel or provide more or less flexibility for entering routes and markets. For example, if policymakers want to reduce carbon emissions from air travel, they may consider implementing a tax on airfares. The price elasticity of demand can help estimate how much demand for air travel will decrease as a result of the tax. In our regression model the price (fare) elasticity of demand is caluulated in the following way.

(3) $\eta = \frac{\%\Delta\sqrt{P}}{\%\Delta Q} = \frac{P}{\sqrt{Q}}\left(\frac{d\sqrt{Q}}{dP}\right)$ – the conventional price elasticity is defined in this way

(4) $\sqrt{Q} = a + bP$

(5) $\frac{d\sqrt{Q}}{2\sqrt{Q}} = b\,dP$

(6) $\frac{d\sqrt{Q}}{dP} = 2b\sqrt{Q}$

After substitution of 6 in 3 we have:

(7) $\eta = 2bP$

We calculated the price elasticity of demand for short-haul (less than 800 miles) and long-haul (more than 800 miles) flights, with starting point of 1st Quartile, mean and 3rd Quartile, and the results are shown below:

Starting point = Average Price

Short-haul: -0.208569

Long-haul: -3.802023

Starting point = 1st Quartile of Price

Short-haul: -0.3368712

Long-haul: -4.122396

Starting point = 3rd Quartile of Price

Short-haul: -0.7055674

Long-haul: -4.122396

As we see the price elasticity of short haul flights are less than long haul flights. The average price elasticity across all routes is close to what had been estimated by other researchers, in other markets using different data sets (see, Gillen, Morrison and Stewart, 2003 for a discussion). It is generally expected that the price elasticity of demand for short-haul flights in Canada is lower (less elastic) than the price elasticity of demand for long-haul flights mainly because competition is typically higher in long-haul flights compared to short-haul flights due to several reasons:

Limited number of airlines: Short-haul routes are often dominated by one or only a few airlines, which limits competition. In contrast, long-haul routes tend to have more airlines competing for passengers, especially on popular international routes.

Differentiation: Airlines often compete on the basis of service quality, which is easier to differentiate on long-haul flights due to the length of the journey. For example, airlines may offer more amenities and comfortable seating arrangements on long-haul flights compared to short-haul flights.

Business and premium travel: Leisure travel has multiple segments including holidays for personal pleasure or families, VFR (visiting friends and relatives) and conference travel. Generally, 80 percent of long-haul passengers are leisure passengers and the majority of this segment is price sensitive. In short haul markets, a greater proportion of travel is business and these tend to be less price sensitive.

Revenue Management: Although long-haul flights tend to have higher ticket prices, airlines still compete on price to attract passengers. Long haul flights have larger aircraft and are able to exercise revenue management allowing for a greater range of fares and mixing high yield with low yield traffic.

Small Markets: short haul flights generally involve small markets which means a lack of density economies. Also, small markets use turboprop or smaller jet aircraft which have higher per km seat costs.

Overall, the combination of factors mentioned above results in higher competition in the long-haul flights market compared to short-haul flights.

In addition, our study examined the market reactions when Swoop or Flair are present on a route individually, as well as the differences observed when both airlines are in the market simultaneously. The corresponding findings are summarized in the table below:

Table 7: Average difference of LCC/ULCC presence on FPM of routes

Status in the market	FPM or Yield	Percentage difference from the average FPM of that route
Both Swoop and Flair are in the market	0.127	43%
Only Flair is in the market	0.167	25%
Only Swoop is in the market	0.109	51%
ALL routes	0.224	-

The aforementioned table indicates that when both Swoop and Flair are present in the market, the Fare per Mile (FPM) is considerably lower compared to when Flair operates alone. This could be attributed to increased competition, prompting both airlines to lower their prices in order to attract more demand and gain an advantage over each other. Based on the literature reviewed in Chapter 2 (Bachwich and Wittman, 2017), we initially assumed that airfares would be lower when both airlines are in the market compared to when either one operates individually. However, the data presented in the table reveals that the FPM is lowest when Swoop is present without Flair in the market. This could potentially be influenced by the support Swoop received from WestJet, as there are no routes where WestJet and Swoop share. When Swoop entered the Canadian market, WestJet transferred a number of routes (and passengers) to Swoop as the data show a significant decrease in numbers of passengers on WestJet and a rapid increase in Swoop passengers. We did observe that rate of increase in Swoop passengers exceeded the rate of reduction in WestJet passengers, implying that Swoop grew the market and may have also competed away some price sensitive Flair passengers. On all routes where Swoop operates, there is no chance of one of the two Full-Service Carriers (FSCs) being present in Canada, which likely contributes to a decrease in the average FPM on those routes. Conversely, when Flair operates in the market, the data indicates competition with both Air Canada and WestJet on multiple routes, resulting in higher average airfares but Flair fares are consistently lower than either Air Canada or WestJet.[21]

[21] This refers to average economy fares. With revenue management, there will be some seats on both Air Canada and WestJet that may sell for fares that come near to what Flair is charging, but the number of seats offered at these low fares is small.

Chapter 6: Conclusion

This research stands as the first empirical study to examine the impact of Low-Cost Carriers (LCCs) and Ultra-Low-Cost Carriers (ULCCs) on airfares and market structure in the Canadian aviation industry and only the second study that compares the fare impact of LCC with ULCC. The availability of Canadian aviation data spanning from 2014 to 2022 allowed for a granular analysis, taking into account various factors that distinguish Canada from the U.S. and Europe, such as geographical shape, population, GDP, number of cities, and the dominance of a former government-owned airline in most markets. While Canada shares similarities with the U.S. in terms of distance, it lacks comparable population density, not many large markets, lower disposable household income and fewer aviation use intensive businesses.

The research investigates three primary matters:

(A) Identifying factors that influence airfares and passenger demand in the Canadian aviation market.

(B) Differentiating the fare and market growth effects of ULCC and LCC entry into the market.

(C) Calculating the fare elasticity of demand for both short-haul and long-haul traffic in the Canadian domestic market.

In Chapter 3, a detailed analysis of the data was conducted, revealing trends in airfares and air travel demand. Assumptions were made regarding factors that could potentially impact these trends, including GDP, population at origin and destination, number of stops, and etc. Chapter 4 utilized the information gathered in Chapter 3, along with a review of existing research literature, to establish a theoretical model for airfares and passenger behavior. The validity of this model was assessed by examining the endogeneity between variables in the regression model. Finally, Chapter 5 implemented the model on the dataset, yielding remarkable results that supported the assumptions and aligned with the existing literature. The price elasticity of demand was calculated for short-haul and long-haul flights, with the findings indicating that short-haul flights exhibited lower price elasticity compared to long-haul flights. This is generally expected due to higher competition in long-haul flights and various factors such as limited airlines, differentiation, business and premium travel, and price competition influencing the markets.

In the fare and market growth comparison of LCC with ULCC, we found that Flair's entry appears to have a more significant influence than Swoop's on reducing airfares in the market. However, it was not possible to establish to what extent fares that had fallen would rise to some percentage of their pre-entry level. Nor was it possible to examine market dynamics in the sense that ULCCs tend to be more footloose and will abandon markets more readily than is the case with LCCs.

regarding market growth, the results showed both airlines grew the market rather than stealing traffic from other carriers. They were able to capture passengers from other modes but most likely from other activities, something which has also been found for U.S. and European LCC carriers. Flair increased the demand more than Swoop. We found in examining the data that when Swoop was introduced there was a notable shift in passengers from WestJet to Swoop. There is evidence that Swoop did grow the market but not as much as would be implied by the coefficient on the Swoop 'Emergence' variable.

However, the research does face certain challenges primarily related to the data. One issue stems from the impact of COVID-19 and the subsequent recovery phase, along with the grounding of Boeing 737Max aircraft, which effectively eliminated approximately three years' of data. Although there may be ways to address this problem, the simultaneous occurrence of these events makes it more challenging to differentiate their effects. Another problem is that the data was presented on a monthly basis instead of using an actual 10 percent sample as seen in the U.S.; each observation presents the average fare in a given month and average monthly number of passengers carried by a given airline on a particular route.

In terms of further research, it is assumed that results would differ if the transborder and international markets were considered. Notably, the transborder market experiences significant leisure traffic during the winter season, where Air Canada's dominance through its alliance with United Airlines is likely to be a prominent influence. Examining the influence of Swoop, Flair, and Sunwing on the transborder market, given the greater competition, would be of interest.

Variations in the dominance of different alliances between Europe, South America, and Southeast Asia could be explored. Incorporating immigration policies and statistics into the aviation section could shed light on the impact of long-haul travel, with a significant portion consisting of leisure and visiting friends and family. Understanding how affordability, the growth of a middle-class population and the migration across countries in countries affect travel preferences would be a valuable consideration.

Lastly, while the research focused on the economy class, it would be worthwhile to investigate whether the inclusion of other fare classes would alter the results, even though Swoop and Flair offer only one fare class.

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Appendix

Year	Authors	Title	Data	Summery	Models	Results
2022	Christian Bontemps & Cristina Gualdani & Kevin Remmy	Price Competition and Endogenous Product Choice in Networks: Evidence from the US Airline Industry.	(DB1B) second quarter of 2011	Two-stage model of airline competition in which firms first form the networks of markets to be served and then compete in prices.	Standard approach for supply and demand models with differentiated products. Provides models that are useful to estimate market structure from data that are relatively easy to obtain. Also solve the econometric challenges for these models.	In the first stage, they found that fixed costs increase in the number of destinations reachable from hub airports. On the supply side of the second stage, they found that marginal costs decrease in the number of flights (direct or one-stop) offered out of the endpoints. On the demand side of the second stage, they found that consumer utility increases in the number of direct connections that can be reached from the endpoints.
2022	David Scotti & Martin Dresner	The Impact of Low-cost Carriers' Growth on the Air Networks of European Network Carriers	1997–2018 from five European NCs OAG	Main question: How European NC network and capacity-allocation strategies have evolved in response to LCCs competition. NCs have reacted to LCC competition mainly by operating more centralized and less transitive air networks, a strategy consistent with strengthening hub-and-spoke structures.	Social Network analysis finding the measures of Networks for LCCs and NCs for all years in dataset.	Show that LCCs have driven the NCs to centralize their network structures. This structure has decreased the density of the networks, reducing non-stop point-to-point routings by the NCs.

2022	Sri Lakshmi Vadlamani	Using machine learning to analyze and predict entry patterns of low-cost airlines: A study of Southwest Airlines	DB1B 2018	This paper uses machine learning to analyze and predict entry patterns of Southwest Airlines into various city pair. The purpose is to understand the parameters impacting the decision to enter into a city pair, by a low-cost airline. (1) Estimate the factors that motivate a LCC to enter a city-pair market based on certain exogenous (independent) factors. (2) Predict (in-sample) the most possible or likely candidates for future non-stop entry.	Supervised machine learning to understand and predict a low-cost airlines decision to enter (exit) a specific city pair. **Logistic Regression /Decision Trees /Support Vector Machine /Skope rule Classifier /Random Forest**	The most important factor influencing Southwest Airline's decision to fly on a specific route is recognized to be the already existing infrastructure that Southwest has in place in either of the city pair. This reflects network externality, which means it benefits from existing infrastructure and human resources that are already in place in a city
2021	Nicolo` Avogadro	A tale of airline competition: When full-service carriers undercut, low-cost carriers fares	All the flights operating from Italian airports to either domestic or European destinations from January 1 to December 31, 2017.	Investigate the occurrence of **LCCs sometimes offering higher fares than FSCs on competing flights.**	Multivariate logistic regression model. As explanatory variables, they consider both flights' characteristics such as month, day, and hour of departure, specific route characteristics such as degree of competition, departure/arrival airport distances, and population, and finally carriers' business scale and service level.	One of the promising results: The coefficient of the variable "days before departure" is statistically significant and negative, which implies an increase in the phenomenon when approaching the date of the flight. This might be directly attributed to the different practices of dynamic pricing, LCCs being less aggressive in the days close to the flight departure, in comparison with the milder approach typical of FSCs

2018	Ambarish Chandra and Mara Lederman	Revisiting the Relationship between Competition and Price Discrimination†	Airport Data Intelligence (ADI)	Revisit the relationship between competition and price discrimination. Theoretically, if consumers differ in terms of both their underlying willingness-to-pay and their brand loyalty, competition may increase price differences between some consumers while decreasing them between others.	**Estimate the effect of competition on a specific fare** $\log p_{rt}^{i} = \beta_0 + \beta_1^{i} Competition_{rt} +$ **Variables Used in the Regressions** Business fare/ Coach fare/Num. direct rivals/ Duopoly/Competitive/HHI Regressions identify the impact of market structure on fares by exploiting changes in the number of carriers serving a route over time. Develop an instrumental variables (IV) strategy and ensure that the results presented are not influenced by the potential endogeneity of the market structure measures.	Empirically, they found that competition has little impact at the **top** or the **bottom** of the price distribution but a significant impact in the middle.
2018	Virginie Lurkin et al	Modeling competition among airline itineraries	Theoritical	Provide a choice model to forecast the probability an airline passenger chooses a specific itinerary.	Extend prior analysis to include inter-itinerary competition along three dimensions: nonstop versus connecting levels of service, carrier, and time of day using nested logit (NL) and ordered generalized extreme value (OGEV) models. To the best of our knowledge, these are the first NL and OGEV	Concluded that customer preferences, on average, have been stable over time and are similar across distribution channels

					itinerary choice models to correct for price endogeneity.	
2018	Victor Valdes, David Gillen	The consumer welfare effects of slot concentration and reallocation: A study of Mexico City International Airport	Data from domestic operations to/from Mexico City International Airport (MEX) Jun to Dec 2014	This paper utilizes a data panel of domestic flights to/from Mexico City International Airport to estimate a structural model for air travel. The model provides parameter estimates of the impact of slot control, flight frequency and market structure on airfares. The model is used to develop measures of consumer welfare changes with slot reallocation from a legacy carrier to two LCCs.	Econometric estimation of air travel demand & Econometric estimation of price equation. Dependent variable: ln_airfare Method: Panel G2SLS regression ln_flight_frequency / ln_airline_share /lcc_share /lcc / ln_dis / dummy variables of months	The key results were frequency on balance leads to lower airfares; an increase in airline share, an indicator of route market power, increases airfares and a decrease in slot concentration at the airport does not affect airfares.
2018	Stephanie Atallah, et al	The evolution of low-cost Carrier operational strategies pre- and post-recession	OAG schedule data from 2005 to 2015	Analysis of low-cost carrier (LCC) competition strategies for Continental US (CONUS) domestic markets.	Time series analysis	LCCs have gravitated more towards serving large markets (i.e. Large-Large and Large-Medium), including entering markets that already have 2 or 3 competitors present. Post-recession, LCCs have shown preference to competing with major carriers over other LCC airlines.

2017	Ruowei Chen	Competitive responses of an established airline to the entry of a low-cost carrier into its hub airports	OAG Data/ January 2006 to December 2009.	This paper investigates the competitive responses of China Eastern to the entry of Spring Airlines into its hub airports in Shanghai Spring put downward pressure on the average fares of China Eastern and other FSAs. China Eastern responded more aggressively to Spring's competition than competition from other FSAs on routes from the same and nearby airports	To assess the effects of competition on airfares, a reduced form price equation is developed as follows: $\ln Fare_{it} = \alpha_0 + \alpha_1 Spring_{it} + \alpha_2 Spring\_Adj_{it}$ $+ \alpha_4 NFSA\_Adj_{it} + \alpha_5 \ln Dist_i + \alpha_6$ $+ \alpha_7 \ln OAPHHI_{it} + \alpha_8 \ln DAPHHI_i$ $+ \alpha_{10} Tourist_i + \alpha_{11} \ln Income_{it} +$ $+ \sum_{m=1}^{47} \gamma_m Time_m + u_{it}$	The moderate price reduction of 4%e4.9% suggests that China Eastern did not perceive Spring as a serious competitor. Such limited impacts are due to restrictions imposed by the regulator onto Spring Airlines in terms of capacity control and access to major trunk routes as well as undesirable slots which reduce Spring's competi- tiveness against China Eastern.
2017	Alexander R. Bachwich, Michael D. Wittman	The emergence and effects of the ultra-low cost carrier (ULCC) business model in the U.S. airline industry	DOT 2010-2015	Conduct an analysis of ULCCs in the U.S. aviation industry and demonstrate how these carriers' business models, costs, and effects on air transportation markets differ from those of the traditional LCCs.	Using two-way fixed effects econometric model to isolate the effects of ULCC and/or LCC presence on base market airfares. Yit is the log mean one-way fare in market t in year i. $Y_{it} = \alpha_i + \beta_{1t} LCCPre$ $+\beta_{3t} ULCCPresen$ For the analysis of entry/exit impacts, based the model on the ordinary least squares (OLS) regression.	Found that in 2015, ULCC presence in a market was associated with market base fares 21% lower than average, as compared to an 8% average reduction for LCC presence. Also found that while ULCC and LCC entry both result in a 14% average reduction in fares one year after entry, ULCCs are three times as likely to abandon a market within two years of entry than are the LCCs.

2015	David Gillen 'Tim Hazledine	The economics and geography of regional airline services in six countries	Australia/ Canada/New Zealand/Oregon/Arizona/Colorado (U.S.)/Norway/Sweden website flightstats.com March/April 2013	Main Question: is there a difference between the determinants of pricing on reginal routes and main trunk routes?	Estimated a quite standard augmented gravity model of the log of **the number of seats** available daily on all the 209 regional and the sample of 22 main trunk routes. Used logs of origin and destination populations as the gravity attractors, and log of air distance between cities or regional centers as the presumed deterrent factor for travel. Not identified a significant effect of distance on supply of seats, Dependent variable: LOG(SEATS) LOG(POPO) /LOG(POPD) /LOG(DISTAIR) /RATTIME /HHI/ HHI *TRUNK/ SUBSIDY *LOG(POPO)/ TOURIST/ CANADA/ NZ justified in treating HHI as an exogenous variable in our system Dependent variable:	Estimate a well-specified airfare model, which shows strong effects of competition on prices, quite substantial intertemporal price discrimination, and interesting differences between regional and main trunk route pricing. Conclude that if any new airline – LCC or not – enters one of the regional routes they predict a lowering of incumbent prices simply through the effect on market competition.

					LOG(PRICE) LOG(DISTAIR)/ DAYSB4/DAYSB4 *TRUNK /STOPS /STOPS *NONSTOP/ STOPS *TRUNK /JET/SMALL/HOLIDAY /HHI/HHI *TRUNK /countries and airlines	
2013	Winai Homsombat , Zheng Lei , Xiaowen Fu	Competitive effects of the airlines-within-airlines strategy – Pricing and route entry patterns	OAG, 2011, Quarter1	Effects of the airlines-within-airlines strategy adopted by Qantas airline group, which simultaneously runs a full-service airline (Qantas Airways) and a low-cost carrier (Jetstar Airways) on pricing and route entry patterns.	**Market competition analysis** Airline pricing reduced-form price equation $\ln P_{ijt}^{k} = \alpha_0 + \alpha_1 \ln Dist_{ij} + \alpha_2 \ln \sqrt{TCAP_{it} \times TCAP_{jt}} + \alpha_3 \ln FREQ_{ijt} + \alpha_4 \ln MinA$ $+ \alpha_6 NFSA_{ijt} + \alpha_7 NLCC_{ijt} + \alpha_8 DualBrand_{ijt} + \sum_m \gamma_m Quarter_m + \sum_n \lambda_n Ye$ **Jetstar's route entry pattern** probit model $D_{ijt}^{JQ-Entry} = \gamma_0 + \gamma_1 Dist_{ij} + \gamma_2 \sqrt{TCAP_{i,t-1} \times TCAP_{j,t-1}} + \gamma_3 MinAPHHI_{ij,t-1} + \gamma_4 MaxAPHH$ $+ \gamma_6 NoJet\_LCC_{ij,t-1} + \gamma_7 Qantas_{ij,t-1} + \gamma_8 MaxJQRoute_{ij,t-1} + \gamma_9 FightingBran$	Showed that Jetstar has been used as a fighting brand against rival low cost carriers. Such a strategy **increases group airlines' prices** at the expenses of rival airlines. Pricing benefits to Qantas Group come from increased market power as well as service quality improvements.

2013	Philip G. Gayle, Chi-Yin Wu	A reexamination of incumbents' response to the threat of entry: Evidence from the airline industry	3rd quarter of 2007. DB1B	Identifying the situations in which potential entrants that are effective "competitive threats" to incumbents in the market.	Generalized method of moments (GMM) is used to estimate parameters in the profit equation, while ordinary least squares is used to estimate parameters in the pricing equation Variables: Population / Distance (Distance) /Income/ Slot_dummy/ City 2 /HUB_dummy City2*alliance_dummy/ Number of competing firms / Number of entry threats /	This paper provides evidence that even when a potential entrant has presence at both endpoint airports of a market, incumbents may not respond to this as an effective "entry threat". Specifically, they found that (1) incumbents lower price by more when the potential entrant has a hub at one or both market endpoints; and (2) incumbents increase rather than lower their price if they have an alliance partnership with the "potential entrant".
2013	Jan K. Brueckner, Darin Lee, Ethan S. Singer	Airline competition and domestic US airfares: A comprehensive reappraisal	DOT last two quarters of 2007 and the first two of 2008	This paper extends recent research on the fare impacts of low-cost carriers, incorporating its adjacent-airport approach to offer a comprehensive picture of the competitive effects of both legacy carriers and low-cost carriers.	Regression model for non-stop and connecting flights.	The results show that most forms of legacy-carrier competition have weak effects on average fares. Low-cost carrier competition, on the other hand, has dramatic fare impacts, whether it occurs on the airport-pair, at adjacent airports, or as potential competition.

2012	Dominic Detzen, et all	The impact of low cost airline entry on competition, network expansion, and stock valuations	DB1B 1970 through 2007	Explore the impact of low cost carriers' entry on legacy airline stock prices. Oligopoly structures, entry barriers, and high fixed costs make the airline industry highly susceptible to competitive and network expansion impact of low cost airlines' entry.	Two methodologies are used; **stock price event studies** and **Gaussian statistical analysis**. $\Delta HHI = \beta_0 + \beta_1 LCC + \beta_2 \Delta PaxIndustry + \eta_1$ $\Delta RPM = \gamma_0 + \gamma_1 LCC + \gamma_2 \Delta GDPService + \nu$ $R_{i,q} = \alpha_0 + \alpha_1 \Delta HHI + \alpha_2 \Delta RPM + \alpha_3 (R_m - \ldots$ $+ \alpha_5 HML + \varepsilon_1$	Positive stock returns are observed, which interpreted as the spillover effects of network expansion. Thus, rising passenger traffic and improved connectivity increase the revenues of legacy airlines to sufficiently offset the LCCs competitive threats.
2010	Victor Aguirregabiria & Chun-Yu Ho	A dynamic game of airline network competition: Hub-and-spoke networks and entry deterrence	DB1B. Year 2004	This paper presents an empirical dynamic game of airline network competition that incorporates this entry deterrence motive for using hub-and-spoke networks.	Network Analysis. The effect of entry on the airlines that are in the network. How the network structure would change.	
2008	Bogdan Daraban a, Gary M. Fournier	Incumbent responses to low-cost airline entry and exit: A spatial autoregressive panel data analysis	(DOT) 55 quarters from the first quarter in 1993 to the third quarter in 2006.	Incumbent responses to low-cost airline entry and exit.	$\ln P_{rt} = \alpha_r + \delta_t + \sum_{\tau_{en}=-4}^{4+} \beta_{\tau_{en}} SW\_en\ldots$ $+ \sum_{\tau_{ex}=0}^{4+} \beta_{\tau_{ex}} SW\_exit_{r,t_0+\tau_{ex}}$ $+ \sum_{\tau_{en1}=-4}^{4+} \beta_{\tau_{en1}} LCC\_entry_{r,t_0\ldots}$ $+ \sum_{\tau_{ex1}=0}^{4+} \beta_{\tau_{ex1}} LCC\_exit_{r,t_0+\tau_{ex}}$	Find evidence that the incumbent carriers also cut airfares in anticipation of entry by the LCCs. Moreover fares remain lower even after Southwest Airlines exits. Empirical analysis confirms the spatial dependence among airfares in adjacent routes, provides estimates of the consumer benefits from lower airfares in routes affected by LCCs, and shows that there are substantial indirect benefits, i.e. lower fares in spatially-linked, nearby routes. Found that the indirect effects of LCCs, which are completely overlooked in the OLS specification represent up to 20% of the total

						effects.
2008	Alessandro V.M. Oliveira	An empirical model of low-cost carrier entry	Statistical Yearbook	Competition between low-cost carriers in rapid expansion and full-service network carriers by analyzing the entry of the low- cost Gol Airlines, in the Brazilian domestic market, in 2001	Use Amemiya's Generalized Least Squares (AGLS) to estimate a route-choice model associated with a flexible post-entry equilibrium profits equation, and in which some of the regressors were treated as endogenous.	Results indicate the relevance of market size and rival's route presence as underlying determinants of profitability.
2004	CHARLES BOGUSLASKI1, HARUMI ITO2 and DARIN LEE	Entry Patterns in the Southwest Airlines Route System	U.S. DOT OD1A from 1990 to 2000	Estimate a model of city-pair entry for Southwest In addition to quantifying the market characteristics which have influenced Southwest's entry decisions, they found evidence that Southwest's entry strategies have changed significantly throughout the decade. They provide an estimate of the foregone fare savings resulting from the Wright and Shelby Amendments.	Probit entry models using cross-sectional data empirical goal is mostly descriptive **Two** main aspects of Southwest's entry decisions. **First**, what factors influence the choice of markets Southwest enters? **Second**, how did Southwest's basic entry strategy evolve over the	Identified those markets that are the most likely for future non- stop entry and suggest which network carriers are most vulnerable to future Southwest expansion.

					past decade Target value: post-entry profitability Variables: **ln(dense)/D(distance300)/ln(meanpop)/max(vacation)/max(income)/ min(income)/max(swcities)/ min(swcities)/D(swzero)/ swsharei D(hub)/markethhii /max(cityhhi)/ D(big)/ D(small)/ min(cityhhi)/ D(lowcost)/ N**	
2003	Harumi Ito and Darin Lee	Market Density and Low Cost Carrier Entries in the US Airline Industry: Implications for Future Growth	US Department of Transportation's (DOT) 1990-2002	Confirm that LCCs have concentrated their entries over the past decade primarily on very dense city-pair markets. They demonstrate that if LCCs continue to penetrate markets of similar density at the same rate, the proportion of domestic network carrier revenue that may ultimately be exposed to non-stop LCC competition could rise sharply in the future.	Using a market decomposition analysis finding the Proportion of Domestic Passengers and revenue in Density Bins.	Found that LCCs have primarily targeted markets with high traffic densities that allow them to leverage their comparative cost advantage.

2001	Steven A. Morrison	Actual, Adjacent, and Potential Competition Estimating the Full Effect of Southwest Airlines	DOT year 1998	Southwest Airlines is frequently credited with having an important influence on the success of airline deregulation in the United States. This paper uses an original set of competition variables to estimate the extent of that influence in 1998.	This paper uses an original set of competition variables to quantify the impact that Southwest Airlines has on airfares through actual, adjacent, and potential competition. Regression for airfares: Control Variables: Distance/ Density/ Slots/ Percentage Business/ Concentrated Hubs/ Regional Effects/ Quarterly Effects	Southwest's low fares were directly responsible for $3.4 billion of these savings to passengers. The remaining $9.5 billion represents the effect that actual, adjacent, and potential competition from Southwest had on other carriers' fares.