DEMAND, MARKET STRUCTURE, ENTRY, AND EXIT IN AIRLINE MARKETS

by

DANIEL M. MAHONEY

A DISSERTATION

Presented to the Department of Economics
and the Graduate School of the University of Oregon
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

June 2014

DISSERTATION APPROVAL PAGE

Student: Daniel M. Mahoney

Title: Demand, Market Structure, Entry, and Exit in Airline Markets

This dissertation has been accepted and approved in partial fulfillment of the requirements for the Doctor of Philosophy degree in the Department of Economics by:

Wesley W. Wilson	Chairperson
Van Kolpin	Core Member
Anca Cristea	Core Member
Diane Del Guercio	Institutional Representative

and

Kimberly Andrews Espy	Vice President for Research and Innovation; Dean of the Graduate School

Original approval signatures are on file with the University of Oregon Graduate School.

Degree awarded June 2014

DISSERTATION ABSTRACT

Daniel M. Mahoney

Doctor of Philosophy

Department of Economics

June 2014

Title: Demand, Market Structure, Entry, and Exit in Airline Markets

The airline industry is a major driver of economic activity in the United States, accounting for over $1 trillion annually. In this work, I study the airline industry and analyze several key economic issues facing the industry. I examine the industry from several different angles, looking at consumer behavior, firm behavior, and market performance. The body of the dissertation comprises three essays, with each essay focusing on one of the aforementioned facets of the industry.

The first essay is a study of consumer demand, using aggregate data to estimate consumer utility functions and identify preferences for airports in large, multi-airport markets. Using these utility functions, I produce tables of cross-airline and cross-airport elasticities, measuring how consumers would be expected to substitute between airports in response to airline price increases and substitute between airlines in response to airport price increases. The second essay is a study of market structure and pricing. I look at changes in market structure over a 20 year time period, focusing on the price effects of entry, exit, and mergers. By looking at both the direct effects as well as the subsequent effects on market concentration, I find that there is tremendous heterogeneity in the effects of these events across markets. The final essay is a model of firm entry and exit decisions in a network environment. I use this model to analyze firm decisions in the

airline industry. I find that the size and geographic distribution of firms' networks plays an important role in their decision to further expand or contract, as firms with larger networks are more likely to expand, while firms with smaller networks are more likely to contract. Together, this body of work presents an in-depth analysis of the economic issues surrounding the airline industry.

This dissertation includes both previously published and co-authored material.

CURRICULUM VITAE

NAME OF AUTHOR: Daniel M. Mahoney

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon, Eugene, OR
Brown University, Providence, RI

DEGREES AWARDED:

Doctor of Philosophy, Economics, 2014, University of Oregon
Master of Science, Economics, 2012, University of Oregon
Bachelor of Science, Mathematics, 2007, Brown University

AREAS OF SPECIAL INTEREST:

Industrial Organization

PROFESSIONAL EXPERIENCE:

Graduate Teaching Fellow, University of Oregon, 2009-2014

Summer Assistant Janitor, Williamsburg Elementary School, 2006-2007

GRANTS, AWARDS, AND HONORS:

Academic All-Ivy, 2007

PUBLICATIONS:

Mahoney, Dan, and Wesley W. Wilson. "The Size and Growth of Airports."*Advances in Airline Economics* 3 (2011): 233-273.

TABLE OF CONTENTS

Chapter Page

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

The Federal Aviation Administration (FAA) estimates that the total economic impact of the airline industry to be approximately $1.3 trillion in 2009; accounting for over 10 million jobs, and over 5% of GDP (FAA, 2011). With such a major impact on the national economy, it is only natural that this industry has been a prime target for academic economic research. In this dissertation, I study the economics of the airline industry. The dissertation contains three essays, the first of which is a study of consumer demand in a multi-airport environment; the second is a study of market structure and prices over time; while the final essay studies firm entry and exit decisions into and out of a network. Together these essays produce a better understanding of the competitive environment in which airlines operate.

The dissertation addresses a broad spectrum of issues in the airline industry. These topics include demand modeling, market structure, equilibrium, and pricing. I build off the existing academic literature and address topics that have relevant academic interest, but also are central to the understanding of the industry. Given the government's regulation of the industry, many of the topics I address relate to pricing and competitiveness, and are of particular relevance to policymakers. The dissertation is structured as three chapters, each an independent essay addressing a different facet of the industry and summaries of those chapters are as follows.

Commercial airlines offer a service transporting passengers between airports. The airports are a necessary prerequisite, but due to the significant land requirements of an airport, airports are typically municipally owned and out of the control of the airlines that operate from them. This often serves to limit competition through a variety of ways that are not present in other industries. Airlines cannot locate freely, and airports themselves are often capacity-constrained. It is through the necessity of airports that I begin my study, by examining the role that the airports themselves play in consumer decision making. In order for consumers to fly, they must choose a pair of airports to fly between. In some cases, geographic conditions leave consumers with only a single realistic option; however, many of the largest cities are served by multiple airports. By providing consumers with a choice of airports, this can potentially increase the competition, depending on how willing consumers are to substitute between these airports.

Chapter II is a study of consumer demand, focusing on the issue of consumer substitution effects in multi-airport markets. A version of this chapter is published, with co-author Wesley Wilson. In it, we use a random-coefficients logit model to estimate a consumer utility function for air travel, along the lines of Berry, Carnall, and Spiller (2006). Once this utility function is estimated, it can be used to predict consumer behavioral responses. We simulate changes in airport prices in multi-airport markets, and measure the substitution effect between airports. This is done for both airport level price increases and firm-level price increases (whose total effect depends on the firm's relative presence at each airport).

Though the airports are relatively fixed, the industry has experienced significant changes in market structure in recent history due to major changes among the airlines. Many of the largest airlines have either gone bankrupt, or merged with some of their previous rivals. Additionally, many firms made significant changed to the scope of their network over that time period.

Chapter III examines how market structure has changed over time as the result of entry, exit, and mergers, and the effects that these have had on prices. I do this using twenty years of data on airline prices and service. Similar studies of price and market structure in the airline industry typically use cross-sectional data or, if multiple time periods are utilized, only a few years. By using a longer panel of data, I am able to better track firm entry, exit, and mergers over that time period, and agglomerate them all into a single model. I estimate the effects that these events have on prices, both at the firm and market level. Overall, I find the effects vary substantially by market, but several patterns emerge. New entrants typically make markets more competitive, offering lower fares, and reducing the fares of their rivals. Conversely, firms exiting the market have no apparent effect on the pricing behavior of their former rivals. The effects of mergers vary drastically by market, particularly in how much the merger changes market concentration. Even with the high variance, the average price effect of a merger appears to be slightly negative, suggesting that the cost-efficiency effects of a merger are significant, even more than the market consolidating effects.

Chapter IV focuses on entry decisions for firms in the airline industry. While past studies, such as Reiss and Spiller (1989) and Berry (1992) look at firms' decisions to enter a particular origin-destination market, in this paper I take a step back and first look at the firms' decisions to offer service at the airport level. Due to the hub-and-spoke network structure that most airlines employ, so long as they have a presence at each endpoint, they are able to offer service between them on demand. Thus, instead of looking at particular routes, I examine the issue of firm presence on a network. Because of this networked relationship, firms' incentives and subsequent entry decisions are dependent on their existing presence on the network. In this paper, I develop a model of entry into networked markets, and use it to estimate an empirical model of entry, based upon market characteristics and network structure.

Collectively, these three essays comprise a body of work that advances the fields of airline economics, touching upon three major areas of industrial organization: consumer decision-making, firm decision-making, and market performance. Particular focus is paid to the role of airports in determining firm network structure and consumer decision-making, as these characteristics distinguish the airline industry from many others.

CHAPTER II

AIRPORT AND AIRLINE SUBSTITUTION EFFECTS IN MULTI-AIRPORT MARKETS

This work is to be published in *Advances in Airline Economics Volume 4: The Economics of International Airline Transportation*. I was the primary contributor to this work, performing the data work, programming, and estimation routines, as well as most of the writing. Wesley Wilson supplemented some of the writing to help make it suitable for publication.

1. Introduction

In the airline markets, there are nearly a billion passengers per year and approximately $1.3 trillion in total economic impact annually (IATA 2011). It follows that a better understanding of the nature of this industry is of interest to businesspeople, consumers, and academic economists alike. By the nature of air transportation, purchasing a ticket to a particular destination necessitates the implicit choice of an airport as well. The purpose of this paper is to create a model of consumer demand and to identify preferences for airline characteristics, and airport characteristics. This demand model is applied to multi-airport markets to estimate consumer substitution patterns both between airlines and between airports.

For consumers in some geographic locations, there is only one feasible origin-destination pair; however, many of the largest markets are served by multiple airports. The purpose of this study is to better understand the relative importance of the airports themselves in the consumers' decision making process. There are many reasons why consumers may prefer a particular airport. It may be a feature of location, such as distance or access infrastructure (roadways, public transportation, etc.). It may be particular airport amenities, or it may simply be due to a consumer's history with a particular facility. The interaction between airports and airlines may also be a factor. The effects of airline dominance of an airport have been well documented, going back to Borenstein (1989). Often dubbed the "hub premium," there is ample evidence that consumers are willing to pay a premium to fly with the airline with a predominant market share at a given airport.

In this paper, I adapt the model of airline demand from Berry, Carnall, and Spiller (2006) to address the subject of consumer substitution patterns between airports. This approach is a discrete-choice, random coefficients demand model derived from market-level data, that is used to estimate consumer demand parameters for airport and airline characteristics. The estimated parameters can then be used to estimate change in consumer behavior in response to the set of available products. In particular, it focuses on how consumers substitute across different origin airports in a multi-airport market when faced with a fare increase that is localized to a single airport. I also examine how consumers substitute across airports when faced with a fare increase from a particular airline.

Evaluating the results across different markets, substitution out of the market tends to dominate. In response to an airport-wide price increase, approximately 70% of those passengers that choose to abandon their original airport will opt out of the air travel market entirely, rather than fly from an alternative airport, though there was considerable variability across markets, and even across airports within the same market. Among the consumers who do switch to a different airport, again the results vary, with no discernible patterns based upon the data available. The overall magnitude of substitution is another feature that shows wide variation between markets. There is relatively high substitutability in the New York City metropolitan market (characterized by own-price airport elasticities greater than 2%), and relatively low substitutability in the Washington D.C. metropolitan market (characterized by elasticities less than 1%).

Such results may be of interest to policy-makers, who are considering infrastructure decisions. The price changes considered in this paper could be driven by direct taxes or fees on the departing airports, or they could also be thought of as being driven by ground access costs. This paper provides initial estimates on the extent that airport price changes may drive customers in or out of the market, and to what extent they will simply cause a reallocation of customers among the existing airports in the market.

2. Literature Review

There is a rich and growing literature on the air industry. This literature has given a plethora of knowledge that applies to the industry but also has influenced the more general economics literature in areas such as network analysis or consumer choice, among others. In this section, I describe three distinct areas. Section 2.1 covers the relationship between airlines and airports. Section 2.2 addresses the question of the relevant market of an airport, while Section 2.3 presents an overview of consumer choice modeling, as applied to the airline industry.

2.1. Airlines and Airports

Airlines rely on airports to conduct their operations, and the relationships between the two can have significant effects on the outcome of the market, particularly the demonstrated market power of firms. Since the onset of deregulation in 1978, market power and pricing have been the focus of much academic research. Graham, Kaplan, and Sibley (1983) test two hypotheses of deregulation in particular: first, that air carriers were running excess capacity prior to deregulation, and second, that potential competition would keep fares low, even in highly concentrated markets. Their results are consistent with airline load factors increasing significantly in the years following deregulation. They also find that broad market demand characteristics can explain a high percentage of observed fares, however, they reject the hypothesis that potential competition is sufficient to drive down fares. Instead, observed airfare is highly correlated with measures of market concentration. This result ran counter to earlier results, such as that by Bailey and Panzar (1981) which claimed that airlines were perfectly contestable. Morrison and Winston (1987) also test the contestability of airline markets, and similarly find that the markets were imperfectly contestable.

Though the Graham, Kaplan, and Sibley find market concentration was correlated with higher observed fares, however, they stop short of identifying the source of the pricing power, even in markets that appeared to be contestable. Borenstein (1989) examines the role of airport dominance in airline pricing power. By estimating a pricing equation that includes both measures of concentration at the route-level, as well as market concentration at the origin and destination airports, he finds that a carrier's share of both route and total airport traffic have significant effects on pricing. While it is expected that airlines with a greater share of route traffic are able to charge higher prices as a result of their market power, it is less apparent why the airline's overall presence should influence pricing on a particular route. The explanation may lie in the prevalence of consumer loyalty programs. One such loyalty program--frequent flyer miles--rewards customers who do repeated business with a particular airline. When frequent flyer programs are present, customers may prefer an airline that offers the most flight options from their local airport, as their airline decision depends on both the current flight as well as expected future flights. Other potential explanations include travel agent commission override bonuses, which pay travel agents for directing a specified level of traffic to a particular airline. There may also be common advertising costs for an airline in a local market. Though the exact mechanisms were left unidentified, it was clear that subsequent studies of airline demand needed to account for carriers' presence at an airport, not just along a particular route.

Airline presence at an airport has a strong influence on pricing, and so it is natural to further study the nature of the vertical relationship between airports and airlines. As pointed out by Oum and Fu (2008), airport revenues come from two primary sources. The first source is charges for aeronautical services. These include take-off and landing fees, terminal rental, aircraft parking, and other such services directly related to the facilitation of flights. The second source of airport revenue comes from non-aeronautical services, such as parking, concessions, office rental, and other commercial uses of airport land. For these services, airports possess significant market power, since price elasticity of demand is very low. Several key factors determine airport market power. The first is airport capacity relative to demand. In most of the United States, Europe and Asia, air traffic demands have been increasing by approximately 5% per year, and airport infrastructure has not kept up with this growth. The second is regional airport competition; when multiple airports serve the same metropolitan area, market power among both airports is reduced, so long as these airports do not share common ownership. The share of connecting passengers also is an important determinant of airport market power. While local traffic is relatively inflexible, both passengers and airlines are free to choose between different hub airports. Because of the intertwined relationship between airports and airlines, it may often be beneficial to adopt some level of integration between the two. These relationships may serve to guard against risk, internalize demand externalities, or gain a competitive advantage over other airports and airlines. This integration may take several forms. Airlines may own shares in the airport, or may engage in long-term contracts to guard the airport against risk; in exchange for offering the airline favorable rates.

Airport-airline relationships often serve to strengthen the position of the airport's dominant carrier who is best able to negotiate favorable terms with an airport. These long-term contracts can create a barrier to entry for new firms in the market. Ciliberto and Williams (2010) investigate the role of these arrangements in terms of the "hub premium"--the difference between fares to or from airports where major airlines have hubs relative to comparable trips that do not originate or terminate at a hub airport. Estimating a log-linear pricing specification, Ciliberto and Williams find that the hub premium is present, and increasing in the fare. Unconditionally, they find the hub premium to vary from approximately 10% at the 10th percentile of fare distribution, to

20% at the 90th percentile of fare distribution. The apparent hub premium decreases in magnitude when controls for barriers to entry and airport congestion are added to the model. The hub premium also decreases with the presence of low-cost carrier Southwest Airlines, suggesting that increased competition may eat away at the markup. Airport congestion and airport barriers may explain a significant portion of pricing power, as represented by the hub premium, however, they only account for approximately 50% of the observed hub premium. They attribute the remaining 50% to the hub market power factors outlined by Borenstein (1989), such as loyalty programs, travel agent commissions, and familiarity biases.

Though airports provide a barrier to entry that can increase market power among the airlines in the market, they also serve as a source of congestion. The relationship between barriers to entry and airport congestion is the subject of a paper by Dresner, Windle and Yao (2002). They examine several barriers, including slot controls, gate constraints, and gate utilization during peak operating periods. They estimate both a choice model for the airline's entry decision, as well as a standard regression on passengers and yield (defined as average price per passenger-mile). Their findings indicate that all three variables have a statistically significantly positive effect on yield. Only one barrier, gate utilization during peak operating periods, had a significant effect on airline entry into a market. Their results are indicative that although contracts between airports and dominant airlines may correlate with greater market power, unless the airport is capacity-constrained, these contracts will not be able to inhibit new entry.

Another concern associated with airport congestion is the costs imposed by an airline's flight due to congestion. Though weather is the single largest source of delays in the U.S. airline industry, in most cases "volume" delays, caused by traffic exceeding airport capacity, is the second-largest source of delay. Brueckner (2002) considers the effects of congestion pricing in the airline industry, and compares it to the results of the road-pricing literature. Contrary to road-pricing, in the airline industry, firms with market power internalize some of the congestion costs of their own flights. In the case of the monopolist, the congestion costs will be fully internalized. In the case of an oligopoly, the firms internalize the portion of the congestion costs imposed on themselves. Pels and Verhoef (2004) derive a similar model of congestion costs with market power and, like Brueckner, find that a naïve congestion toll will be too large, and may actually be welfare-reducing. Their model also incorporates regulator coordination issues, particularly in the case where origin and destination airports are located in different countries, and subject to differing regulatory agencies. Without coordination, the incentive to reduce tolls to the optimal level is disproportionately reduced, leading to an inefficient outcome.

Airport congestion is also affected by the size of airplanes. As the number of runways, gates, and departure times are fixed in the short-term, larger airplanes may be the only way to increase passenger volume. Wei and Hansen (2004) estimate a nested logit model to study the relationship between aircraft size, service frequency, seat availability, airline fares, and market share. They find that airlines can realize higher returns from increasing flight frequency compared to utilizing larger aircraft. Though there may be cost-savings associated with a larger aircraft, holding other factors constant, passengers do not display preference for a particularly sized aircraft. Instead, passengers display a preference for greater choice in departure time. In this case, the airlines choose to fly airplanes that are smaller than those that would minimize the cost per passenger-mile.

Related to airport congestion, a critical issue to understand is the optimal market size of a city-pair route at an airport. As airport market size increases, unit operating costs decrease as airlines are able to use larger aircraft filled to greater capacity. A larger airport, however, may face greater delays as it encounter capacity constraints. As the airport increases its market size, the average airport access costs rise, as customers must travel from further away. Hsu and Wu (1997) attempt to model this problem, and solve for the optimal airport market size using linear programming techniques. Using hypothetical estimates of various parameters, they find that airports operate more efficiently in markets with greater population density. Cities with greater per-capita income allow an airport to serve a larger market size, along with a larger market area. Finally, they find that stability among passenger demand allow airports to operate more efficiently.

2.2. Market Definition

More generally, the question of market identification is an important one in airline research. For demand models, identifying which airports are in the consumers' choice set is necessary to obtain proper estimates, and subsequent models of pricing and competition also require such a market to be properly identified.

Forsyth (2006) outlines several of the potential issues when a city's dominant airport faces competition from smaller, fringe airports. Most major cities feature a single dominant airport, located either within, or near the city limits. More recently, there has been growth in secondary airports, which has been associated with the growth of low cost carriers (LCCs). The secondary airports are often less convenient for consumers, and so they compete largely on price; appealing to the more price-sensitive consumers who are willing to sacrifice some of the benefits of flying with the larger, full service carriers (FSCs). When the LCCs at fringe airports enter the market, it may or may not improve overall efficiency in the market. In the case when a major airport has excess capacity, and the markup above marginal cost is designed to cover the airport's substantial sunk costs, the airlines may not be able to adjust their pricing to appropriately compete, and an inefficient allocation will be realized. Inefficient allocations may also arise if the secondary airports are receiving subsidies. Conversely, if the secondary airports and the LCCs cost advantages are due to greater efficiency, competition in the market will have a positive effect.

Morrison (2001) attempts to directly estimate some of the gains offered by low cost carriers operating out of regional airports. In a study commissioned by Southwest Airlines, he looks at the effects of Southwest's competition on the U.S. airline industry. When considering the effect of a low cost carrier, such as Southwest, competition may come by the LCC serving the same route in question as the major carriers, or it may come by the LCC serving some combination of the same or adjacent airports. Estimating the effects of Southwest Airlines on fares, for a single year (1998), Morrison finds that competition from Southwest resulted in $12.9 billion in savings, $3.4 of which from Southwest's own fares, while the remaining savings came from other airline's lower fares. The cost-savings are greatest when Southwest serves the same route in question as the full service carriers, however, even when Southwest doesn't serve the market in question, but has a presence at either of the endpoints (or their adjacent airports), the threat of entry results in a statistically significant decline in average airfare.

Brueckner, Lee, and Singer (2011) offer a comprehensive evaluation of competition and airline pricing. They estimate the model allowing for in market, adjacent competition as identified by Morrison (2001). Unlike Morrison (2001), they consider not only low cost carrier competition from adjacent airports, but also legacy carrier competition from adjacent airports. The second contribution of the paper is to distinguish between competition from non-stop flights, and competition from connecting flights. Brueckner, Lee, and Singer find that in-market competition from LCCs contributes to lower fares significantly more than competition from legacy airlines. This pattern extends to adjacent competition from LCCs. They find that in many cases, adjacent airport competition from legacy carriers has no effect on airfare. This result holds for competition among both non-stop flights, as well as connecting flights.

2.3. Consumer Choice

Driving these price-effects between adjacent airports is an underlying consumer choice problem. Though not all consumers face a realistic choice of airports to suit their travel needs, several of the largest airline markets, including New York, Los Angeles, Washington, D.C., San Francisco, and Chicago all feature multiple large airports within close geographic proximity to the city. There have been a number of studies done to model the consumer choice problem when both the flight and the airport are choice parameters. One such study by Windle and Dresner (1995) uses survey data for the Washington, D.C. metropolitan area. They found that there were strong proximity-effects, but controlling for passengers with similar access times to multiple airports, flight frequency appeared to be the driving determinant. Not surprisingly, they also found that business travelers valued flight frequency and airport proximity relatively more than leisure travelers, who were more price-sensitive.

Pels, Nijkamp, and Rietveld (2001) perform a similar study using survey data from the San Francisco Bay Area. They model passengers as first choosing their departure airport, and subsequently their particular flight, utilizing a nested logit framework. They find that this model significantly outperforms a direct multinomial logit model. Further extensions of an airport-airline choice model come from Basar and Bhat (2004), who hypothesize that the airport choice set may vary between potential consumers. They implement a probabilistic choice set multinomial logit model, and find that models presenting a uniform choice-set across consumers produce biased estimates.

To estimate an airport-airline choice model, it is ideal to have data on individual consumers and their choices. Such data, however, is not widely available, and consequentially, the aforementioned choice studies tend to rely on common datasets capturing only a few markets over a relatively short period of time. An alternative approach from Berry, Carnall, and Spiller (2006) uses only aggregate data to estimate consumer demand. As such data are widely available, adopting such an approach allows for greater breadth among the estimation results. They use market shares to estimate a random-coefficient choice model, along the lines of Berry, Levinsohn, and Pakes (1995). They use this choice model to examine the impact of hubbing on both costs and demand.

3. Model

I model consumer decision-making with a choice model. The model used follows those developed by Berry et. al (2006) and Berry and Jia (2010). It is a random-coefficient, discrete choice framework. This model assumes a set of consumers in each market who choose from the menu of that market's available products, each offering some utility level (*u*). Specifically, consumer utility function is assumed to take on the following form, where the utility for consumer i, in market t, and product j is given by

$$u_{ijt} = x_{jt}\beta_i - \alpha_i p_{jt} + \xi_{jt} + \nu_{it}(\lambda) + \lambda\epsilon_{ijt} \qquad (1)$$

where x_{jt} is a vector of observable attributes of product j in market t, p_{jt} is the product's price; ν_{it} and λ are nested logit parameters designed to pattern those who participate in the market and those who don't; ϵ_{ijt} is an i.i.d. error term; and ξ_{jt} represents product characteristics that are unobserved to the econometrcian, but observable to the consumer, as presented in Berry, Levinsohn, and Pakes (1995). Collectively, the model parameters (α, β, λ) will all be considered as part of a single parameter vector, θ. The consumer i in market t chooses a product j for which

$$u_{ijt} \geq u_{ikt} \;\; \forall k \qquad (2)$$

Not all consumers may choose to purchase one of the products in the market (in this case, airline travel). Some may choose alternatives means of travel, such as automobile or train, while other consumers may choose not to travel at all. The utility of those who do not participate in the market (those who have implicitly chosen some "outside good") is normalized to

$$u_{i0t} = \epsilon_{i0t} \tag{3}$$

The random consumer taste parameters, β_i and α_i are assumed to take on a two-point distribution with γ and $1-\gamma$ representing the probability that a given consumer is of type 1 or type 2. Colloquially, the two types of consumers are referred to as "business" and "leisure" travelers (as is consistent with prior demand studies that show that those two groups tend to vary—particularly in their price-sensitivity), however, in the data, the reason for travel is never explicitly observed, and so the consumers are identified purely by their demand parameters.

With the consumer utility specified, the market shares can be estimated by integrating the choice probabilities over the number of consumers in the market. If the additive error term takes on an extreme-valued, i.i.d. distribution, the choice probabilities will take on the traditional logit form. Conditional upon purchasing some product, the probability of a consumer of type r choosing product j is

$$s_{rjg} = \frac{e^{\frac{x_{jt}\beta_i - \alpha_i p_{jt} + \xi_{jt}}{\lambda}}}{\sum_{k\in J} e^{\frac{x_{kt}\beta_i - \alpha_i p_{kt} + \xi_{kt}}{\lambda}}} \tag{4}$$

While the probability that a type r consumer chooses any product in the market is given by

$$s_{rt} = \frac{\left(\sum_{k\in J} e^{\frac{x_{kt}\beta_i - \alpha_i p_{kt} + \xi_{kt}}{\lambda}}\right)^{\lambda}}{1 + \left(\sum_{k\in J} e^{\frac{x_{kt}\beta_i - \alpha_i p_{kt} + \xi_{kt}}{\lambda}}\right)^{\lambda}} \tag{5}$$

The total observed market share of product j in market t is

$$s_{jt}(x, p, \xi, \theta) = \gamma * s_{1jg} * s_{1t} + (1 - \gamma) * s_{2jg} * s_{2t} \tag{6}$$

Where θ is the complete set of parameters to be estimated, including $\beta_i, \alpha_i, \lambda,$ and γ. The estimation procedure uses the generalized method of moments (GMM) estimation procedure introduced in Berry, Levinsohn, and Pakes (1995). The Generalized Method of Moments estimator is based on the assumed independence of the unobserved error component, ξ, and a set of instrumental variables, Z. These instruments are made up of variables which are expected to be correlated with the price, but uncorrelated with the error term, ξ. They include all demand variables (except price), cost variables, and market-level attributes. The procedure attempts to find a set of demand parameters, θ, that minimize the difference between the theoretical moment condition and its sample equivalent (in this case, the independence of ξ and the set of instruments).

Specifically, the procedure works as follows. For a given set of parameters, the vector of unobserved product attributes can be solved for by inverting the above market shares equation.[1]

$$\xi = s^{-1}(x, p, s, \theta) \tag{7}$$

To solve for the set of parameters that satisfied the moment condition

$$E(\xi(x, p, s, \theta)|z_t) = 0 \tag{8}$$

where z_t is a vector of instruments. Consequentially, for any function of instruments $h(z_t)$,

[1] See Berry, Levinsohn, and Pakes (1994) for the proof, and necessary conditions, for this so solve for ξ.

$$E\left(h(z_t)\xi(x,p,s,\theta)\right) = 0 \quad (9)$$

In practice, estimating this system first requires inverting the market shares, given by equation (5), to solve for the unobserved product error term, ξ. As this equation cannot be inverted analytically, this is done by means of a contraction mapping, as outlined in Berry, Levinsohn, and Pakes (1995), and modified for this application in Berry, Carnall, and Spiller. (2006). The vector ξ is found by means of the recursive equation

$$\xi^N = \xi^{N-1} + \lambda[\ln s_0 - \ln s(x,p,\xi^{N-1},\theta)] \quad (10)$$

which is iterated until the maximum difference between ξ^N and ξ^{N-1} is less than some specified tolerance. Dubé, Fox, and Su (2008) present numerical analysis of the convergence of this "inner loop" (the process by which the market shares are inverted). They stress a stringent convergence tolerance, to insure that the subsequent "outer loop" (the minimization of the demand parameters) optimization converges appropriately. The aforementioned outer loop optimization involves the minimization of the sample analog to equation (8) over the parameter vector, θ.

The final step is to estimate consumer substitution patterns between airports. Using the demand parameter estimates from above, I estimate the change in predicted market shares (equations 4-6) in response to hypothetical price changes. I do this for two cases. In the first case, I compute the share response to a hypothetical price increase across all flights from a particular airport. Here, consumers may find it worthwhile to switch to a different flight (possibly from the same airline) at a different airport. In the second scenario, I compute the share response to a price increase only to a particular airline (across all airports in the market, if it has a presence at more than one). As consumers substitute flights from other airlines, some may find it worthwhile to choose a different departing airport as well.

There are some concerns as to the applicability of this model to the situation. By the convention established in BCS (2006), products are defined, in part, by their prices. After airlines schedule flights, they engage in dynamic pricing behavior to maximize revenue. As airlines raise or lower their prices in response to perceived demand and competition, the effective consumer choice set varies. As the model assumes that all products are available at all times, this can, potentially lead to biased estimates. Ideally, some facet of product availability is captured in the unobserved product attribute component, ξ, however, this is an imperfect solution to the problem of product availability. To address concerns about the impact of product availability, Berry and Jia (2010) perform a Monte Carlo experiment to estimate the extent of the bias. They conclude that the bias is small, and is unlikely to significantly alter the parameter estimates.

Using this methodology, I am able to produce consumer utility function estimates, which can be applied to hypothetical changes in the available product set to provide some insight on consumer substitution patterns between airports. However, there are a few caveats. The aforementioned issues concerning product availability continue to be present when evaluating substitution patterns in response to a hypothetical price increase. These estimates assume a full complement of alternatives is available. In the short-run, airlines are capacity constrained, and may not be able to support an increase in passengers. Furthermore, if certain flight-fare combinations are offered at a fixed quota, its market share would not grow, no matter how its rivals' prices changed. In such cases the results in section 5 may be upwardly biased, overestimating the substitution among consumers.

There are further concerns about the consistency of the parameter estimates across markets. It is reasonable to expect the composition of consumers to vary greatly by the destination, particularly between standard "tourist" destinations, like Orlando or Las Vegas, and more "business"-oriented destinations like Chicago. To address this concern, I estimate both a model encompassing all U.S. airline markets, as well as a specific model for each of the origin cities of interest. As discussed below, I find the significance of the localized model estimation to vary based on the market, but do not exhibit any clear pattern in their influence of the results.

4. Data

The primary source of data for this study is the United Sates Department of Transportation (DOT) Airline Origin and Destination Survey (DB1B). These data were supplemented by the DOT's Air Carrier Segment Data (T-100). Population and income measures came from the Bureau of Economic Analysis's (BEA) Local Area Personal Income tables.

The DB1B data are a 10% sample of airline tickets sold from reporting carriers, and collected by the Bureau of Transportation Statistics. A market is considered to be a directional airport pair (that is, New York JFK to Los Angeles LAX is considered different than LAX to JFK). Consistent with Berry et al. (2006) and Berry and Jia (2010), I consider only round-trip itineraries, with at most four total flight segments. The sample was further restricted to those in the lower 48 states, serving markets with at least

850,000 people—where the market size is defined as the geometric mean of the populations at the endpoint cities. Round trip fares above $5000, and below $200 were dropped, as these may have been indicative of either data processing errors, or may simply represent extreme outliers that are not reflective of the preponderance of the data.

For this study, a market is defined as a directional city-pair so, for example, a round trip from New York to Los Angeles is distinct from a round trip from Los Angeles to New York. Most cities are served by a single primary airport, and thus, those markets were represented by a unique airport pair. Several large cities (or metropolitan regions) have commonly been identified as being served by multiple airports. Though the exact groupings are not always clear[2] In all, there were six such groups of airports that were sufficiently close to warrant grouping them.

Following Berry et al. (2006), a product is identified as a unique origin-destination flight, from a particular carrier, for a fixed number of connections, at a particular fare. For the purposes of this study, the location of the connection was not specified—that is, it was assumed that consumers cared whether or not their flight had a connection, but not where that connection took place. This was mostly done for computational simplicity, and it is not assumed to bias the results significantly. Along those same lines, fares were clustered into $25 bins—again, this was largely for computational simplicity.

This study uses data from the first quarter of 2010. After all the restrictions were put in place, there remained 251,206 products, representing 2,307 different origin-destination pairs. An assortment of variables was used, intended to capture product-

[2] Brueckner, Lee, and Singer (2011) is devoted to the topic of which airports should be considered clustered. Though this paper chooses to focus on the six multi-airport cities of Berry, Carnall, and Spiller (2006), it could just as well be applied to an extended set of multi-airport cities.

specific characteristics, as well as airport-airline interaction effects. The product specific characteristics include fare, connection, distance, and online ticket sale. Airport-airline interactive features used were a hub dummy variable, and the number of nonstop destinations served by each airline at a particular airport. These, combined with airline dummy variables make up the bulk of the parameters.

To address the question of heterogeneity across different airline markets, I run the estimation routine for both the full sample, as well as several localized markets individually. The full sample includes all flights to or from airports serving a market of greater than 850,000 people (where, again, a market is defined as the geometric mean of the populations of the endpoint cities). Six localized markets were singled out for this study; these markets were chosen as they were the six markets identified in BCS as being served by multiple airports. A list of the six cities, and the airports they encompass, are presented in Table 1.[3]

Table 1: Cities and Airports

City	New York	Washington, D.C.	Chicago	Dallas	San Francisco	Los Angeles
Airports	Newark Liberty (EWR), John F Kennedy (JFK), LaGuardia (LGA)	Baltimore/Washington (BWI), Reagan (DCA), Dulles (IAD),	Chicago Midway (MDW), O'Hare (ORD)	Dallas Love Field (DAL), Dallas Fort Wort (DFW)	Oakland (OAK), San Francisco (SFO), Mineta San Jose (SJC)	Bob Hope (BUR), Los Angeles (LAX) Long Beach (LGB)

Table 2 presents summary statistics for all the key variables used in this study. However, in addition to the demand variables, there is also a need for a number of

[3] The included airports in each city were chosen to be consistent with Berry, Carnall, and Spiller (2006). For a more detailed analysis of city-airport grouping, see Brueckner, Lee, Singer (2013).

instrumental variables. It is assumed that price is endogenous, and central to the method of moments estimation procedure outlined in Section 3 is a vector of instruments. In addition to the set of demand variables (excluding price), additional instruments were chosen that would reflect cost parameters, and competition factors that would affect price. These instruments include a hub variable, if the flight originates, departs, or connects through an airline's hub, a slot controlled dummy variable, and route-level characteristics such as the number of competing airlines in a market. Further instruments were selected from rival product attributes, such as the average rival fare on a route, and the average number of connections. Further instruments, as used in Berry and Jia (2010) are fitted values of the twenty-fifth and seventy-fifth quantile of fares along a given route.

Table 2: Summary Statistics

	Full Sample		New York		Washington, DC		Los Angeles	
N	2,025,688		153,866		94,943		69,954	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Fare	433.8	219.49	469.43	289.43	453.92	239.53	440.8	271.39
Direct Flight	0.65	0.48	0.86	0.34	0.72	0.45	0.75	0.43
Distance (1000 miles)	1.23	0.64	1.42	0.73	1.27	0.73	1.62	0.8
Distance²	1.93	1.88	2.55	2.29	2.14	2.11	3.27	2.37
Nonstop Dest	48.31	41.89	47.18	26.79	43.31	24.89	39.43	18.19
Online Sales	0.71	0.46	0.84	0.37	0.78	0.42	0.81	0.39
Hub	0.78	0.42	0.45	0.5	0.9	0.3	0.73	0.45
Slot Controlled	0.06	0.24	0.58	0.49	0.32	0.47	0	0
Market								
# Carriers	3.5	1.74	4.04	1.97	3.98	1.96	3.99	2.27
# Products	43.59	82	171.9	216.91	153.55	198.24	121.57	175.9

	San Francisco		Chicago		Dallas	
N	66,983		111,407		72,864	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Fare	439.3	256.15	413.64	188.58	478.81	266.22
Direct Flight	0.72	0.45	0.91	0.29	0.87	0.33
Distance (1000 miles)	1.56	0.89	1.11	0.46	1.02	0.33
Distance²	3.22	2.75	1.45	1.07	1.15	0.69
Nonstop Dest	36.59	21.84	89.23	33.04	108.48	42.3
Online Sales	0.81	0.4	0.8	0.4	0.86	0.34
Hub	0.71	0.45	0.95	0.22	0.97	0.18
Slot Controlled	0	0	0	0	0	0
Market						
# Carriers	4.13	2.13	3.42	1.45	3.65	1.74
# Products	140.47	200.64	100.52	114.07	88.28	115.04

5. Results

The complete results from the estimated model are presented in Table 3. Column 1 presents the parameter estimates when the full sample of origin and destination airports is included in the sample. Columns 2-7 represent the parameter estimates when the sample is restricted to a particular origin city (for example, column 2 includes all round-trip destinations originating from New York City). By restricting the sample to a single origin city, it becomes feasible to include origin-airport dummy variables in the model. This better captures unobservable airport effects, than simply having them collected in the error term, as is the case with the full model. The city-specific model is also estimated recognizing that there may be parameter heterogeneity between different markets.

The model estimates presented in Table 3 are taken and used to construct airport price elasticities—these represent the percentage change in originating airport passengers in response to an airport-wide percentage price increase. Though not explicitly addressing the cause of such a price increase, such price increases might arise in response to higher gate or runway fees implemented to combat congestion. These cross-airport elasticities are presented in Table 4.

The elasticity estimates in Table 4 are the percentage response of quantities to a to a one percent change in all round trip flights originating at a specific airport. For example, a 1% fare increase to all round trip flights originating at John F Kennedy International Airport would result in a 2.3% decrease in passengers departing from that airport (corresponding to approximately 10,000 passengers), a .29% increase in the passengers at Newark Liberty International Airport, and a .24% increase in the passengers at LaGuardia Airport (both corresponding to approximately 2,200 and 1.800 passengers respectively). In the Washington, DC metropolitan market, a 1% fare increase at Reagan International Airport would result in a .58% decline in traffic (approximately 11,000 passengers), while Baltimore/Washington International and Dulles International airports would both see increase of about .13% (corresponding to approximately 2,200 and 1,900 passengers, respectively).

Comparing the results across markets, consumers appear to be less responsive to a hypothetical price change at the largest airport in the market. This is consistent with the literature, as the largest airport is typically home to the trunk carriers, often using the airport as a hub. These airlines compete most strongly on non-price characteristics, such as offering direct flights. As rival prices become less-competitive, it is natural to see consumers flock to the dominant carriers.

Comparing the elasticity estimates of the full model to the estimates of the localized models, they are typically quite close. The largest disparities come from the Washington, D.C., and San Francisco metropolitan areas. The full model tends to overstate the substitution effect relatively to the local models.

Though there is substitution across airports, this tends to be dominated by passengers who choose to exit the market entirely. Though the market elasticities presented in Table 4 are smaller than the proportional share of the particular airport, they are still large. Table 5 presents the shares of passengers who, conditional on switching from their original origin airport, choose to exit the market rather than adopt an alternate origin. On average, slightly more than 30% of passengers who abandon their original airport in response to this hypothetical price change will choose to stay in the market.

Across markets, the share is highest at LaGuardia International Airport, and Reagan International Airport, where slightly more than 50% of the passengers will stay in the market, and lowest at Chicago Midway, where fewer than 15% of the passengers stay in the market.

Table 3: Parameter Estimates

		Full Model	New York	Washington, DC	Chicago	Dallas	San Francisco	Los Angeles
Type 1	Parameter	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Fare	-0.0032*	-0.0011*	0.0001	-0.0063*	-0.0010*	-0.0016*	-0.0011*
		(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.0001)	(0.0003)	(0.0002)
	Constant	-9.1551*						
		(0.1891)						
	Connection	0.4100*	-0.6970*	-0.6343*	-2.5416*	-0.4216*	-0.9527*	-0.7047*
		(0.0828)	(0.0490)	(0.0026)	(0.0567)	(0.0490)	(0.2333)	(0.0490)
Type 2								
	Fare	-0.0024*	-0.0001	-0.0009*	-0.0013*	-0.0005*	-0.0011*	-0.0014*
		(0.0000)	(0.0001)	(0.0001)	(0.0003)	(0.0001)	(0.0001)	(0.0003)
	Constant	-5.8173*	0.0462					
		(0.0297)						
	Connection	-0.8790*	-1.0498*	-0.4475*	0.5976*	-0.3481*	-0.4870*	-0.7315*
		(0.0113)	(0.0462)	(0.0425)	(0.0799)	(0.0462)	(0.0370)	(0.0483)
Common								
	Nonstop Destinations	0.0025*	0.0099*	0.0048	-0.0357*	0.0281*	0.0115*	0.0013*
		(0.0000)	(0.0007)	(0.0118)	(0.0049)	(0.0007)	(0.0055)	(0.0003)
	Distance	0.5604*	1.3407*	0.8786*	2.0567*	-0.5265*	-0.8184*	-0.0238
		(0.0073)	(0.0424)	(0.0112)	(0.0546)	(0.0424)	(0.0525)	(0.0577)
	$Distance^2$	-0.1984*	-0.4229*	-0.3379*	-0.6394*	0.0288*	0.1337*	-0.0785*
		(0.0022)	(0.0110)	(0.0381)	(0.0182)	(0.0110)	(0.0134)	(0.0148)
	Online	0.2355*	0.4981*	0.2571*	0.4504*	0.5599*	0.3804*	0.3475*
		(0.0024)	(0.0108)	(0.0306)	(0.0133)	(0.0108)	(0.0135)	(0.0165)
Airlines								
	Southwest	-0.0508*	-0.5091*	0.0513	2.5735*	-1.3551*	-0.3171*	0.0467
		(0.0060)	(0.0483)	(0.0311)	(0.3364)	(0.0483)	(0.0387)	(0.0395)
	American	0.0033	0.0494	-0.3188*	0.9394*	-2.5140*	0.0003	0.1759*
		(0.0059)	(0.0300)	(0.0346)	(0.3421)	(0.0300)	(0.0251)	(0.0338)
	Delta	-0.0051	-0.2148*	-0.4034	0.7438*	-0.6260*	-0.0212	0.1681*
		(0.0056)	(0.0309)	(0.0336)	(0.0929)	(0.0309)	(0.0299)	(0.0305)
	United	-0.0877*	-0.0102	-0.3356*	-1.3001*	-0.2873*	-0.1097*	0.0311
		(0.0058)	(0.0307)	(0.0375)	(0.4731)	(0.0307)	(0.0283)	(0.0361)
	Continental	0	0.0147	-0.3605*	0.0018	-0.2271*	0.0785	0.1702*
		(0.0061)	(0.0402)	(0.0331)	(0.0647)	(0.0402)	(0.0435)	(0.0350)
	Northwest	-0.2735*	-0.2763*	-0.5688*	0.0524	-0.4565*	-0.2048*	-0.2177*
		(0.0068)	(0.0352)	(0.0495)	(0.0620)	(0.0352)	(0.0276)	(0.0425)
	U.S. Airways	-0.1008*	-0.0037	-0.2671*	1.1421*	-0.6464*	-0.1262*	-0.0236
		(0.0057)	(0.0308)	(0.0362)	(0.2661)	(0.0308)	(0.0448)	(0.0291)
	JetBlue	-0.0674*	0.5878*	0.1570*	-1.7648	-0.2064*	0.0321	0.3872*
		(0.0104)	(0.0351)	(0.0740)	(0.0982)	(0.0351)	(0.0681)	(0.0481)
	Airtran	-0.2813*	-0.2749*	-0.1434	0.9564*		-0.1187	-0.0831
		(0.0081)	(0.0434)	(0.0791)	(0.0674)		(0.0711)	(0.0489)
Model								
	Gamma	0.4987*	0.5001*	0.501	0.5005*	0.5001*	0.499	0.4997
		(0.0365)	(0.2159)	(0.3424)	(0.0792)	(0.1096)	(0.5418)	(0.4654)
	Lambda	0.7480*	0.8325*	0.8199*	0.8926*	0.7770*	0.8063*	0.7906*
		(0.0083)	(0.0356)	(0.0468)	(0.0550)	(0.0484)	(0.0411)	(0.0375)

Table 4: Airport Elasticities

New York

	Full Model				Local Model			
	EWR	JFK	LGA	Market	EWR	JFK	LGA	Market
Initial Share	0.395	0.295	0.301		0.395	0.295	0.301	
EWR	-2.465	0.528	0.599	-0.632	-2.138	0.491	0.486	-0.549
JFK	0.302	-2.430	0.248	-0.521	0.299	-2.300	0.251	-0.483
LGA	0.607	0.438	-2.393	-0.373	0.504	0.426	-2.032	-0.305

Washington, DC

	BWI	DCA	IAD	Market	BWI	DCA	IAD	Market
Initial Share	0.453	0.299	0.248		0.453	0.299	0.248	
BWI	-1.724	0.338	0.333	-0.598	-0.584	0.124	0.129	-0.195
DCA	0.365	-1.731	0.374	-0.259	0.124	-0.584	0.133	-0.085
IAD	0.293	0.305	-1.735	-0.206	0.098	0.101	-0.636	-0.083

Chicago

	MDW	ORD	Market	MDW	ORD	Market
Initial Share	0.309	0.691		0.309	0.691	
MDW	-2.203	0.164	-0.567	-1.682	0.111	-0.443
ORD	0.960	-1.457	-0.711	0.733	-0.990	-0.458

Dallas

	DAL	DFW	Market	DAL	DFW	Market
Initial Share	0.208	0.792		0.208	0.792	
DAL	-1.914	0.059	-0.351	-1.055	0.059	-0.172
DFW	0.876	-1.107	-0.696	0.468	-0.723	-0.476

San Francisco

	OAK	SFO	SJC	Market	OAK	SFO	SJC	Market
Initial Share	0.262	0.531	0.207		0.262	0.531	0.207	
OAK	-1.862	0.110	0.151	-0.398	-1.298	0.068	0.099	-0.283
SFO	0.523	-1.471	0.633	-0.514	0.408	-0.846	0.420	-0.256
SJC	0.277	0.246	-1.835	-0.177	0.193	0.136	-1.201	-0.126

Los Angeles

	BUR	LAX	LGB	Market	BUR	LAX	LGB	Market
Initial Share	0.161	0.758	0.081		0.161	0.758	0.081	
BUR	-1.879	0.091	0.258	-0.213	-2.315	0.118	0.204	-0.267
LAX	0.846	-1.063	0.905	-0.596	0.994	-1.427	1.014	-0.839
LGB	0.052	0.020	-2.350	-0.167	0.061	0.036	-2.536	-0.168

Note: Cells refer to a hypothetical percentage increase in all fares for all itineraries originating from the row airport, and the subsequent percentage change in passengers originating from the column airport. The Market column gives the total percentage change in passengers across all airports in response to a price change at a single airport.

Table 5: Exit Shares

		Exit Rate (Full)	Exit Rate (Local)
New York	EWR	0.649	0.650
	JFK	0.727	0.712
	LGA	0.517	0.498
Washington, DC	BWI	0.765	0.739
	DCA	0.501	0.488
	IAD	0.480	0.527
Chicago	MDW	0.833	0.851
	ORD	0.706	0.670
Dallas	DAL	0.880	0.784
	DFW	0.793	0.831
San Francisco	OAK	0.815	0.833
	SFO	0.658	0.569
	SJC	0.465	0.506
Los Angeles	BUR	0.703	0.717
	LAX	0.740	0.776
	LGB	0.876	0.819
Mean		0.694	0.686

Note: This table presents the share of passengers who choose to exit the market entirely, conditional on switching away from their originating airport in response to a price increase. The mean is the unweighted mean across markets.

Tables 16-21, in the appendix, present similar results to Table 4, except rather than reporting the change in airports' traffic given a change in the prices at an airline, it presents the predicted change in traffic at an airport if a particular airline changes its price. For example, in the New York City market, Continental Airlines (which has presently merged with United Airlines, but was operating independently at the time of the sample) operated a hub out of Newark Liberty International Airport. A 1% increase in Continental's fares would cause nearly a 1% drop in Newark's traffic (approximately 7,000 passengers), while JFK and LaGuardia would see an increase of approximately 1,000 and 500 passengers respectively. Though not all passengers are expected to switch airports, or even airlines in response to a price increase, substitution to the outside good (no air travel), tends to significantly outrank substitution within the market.

6. Conclusion

I estimate a model of airline demand, similar to that of Berry, Carnall, and Spiller (2006), with particular attention focused on a set of multi-airport markets. Using the estimated demand parameters, I estimate consumers' preferences and substitution patterns between airports. The degree of substitutability across airports varies based on the market, with the most cross-airport substitution occurring in New York and Los Angeles, and the least in Washington, D.C.. Looking at airline-airport interactions, particularly vulnerable are the airports that cater to low cost carriers, who may not have the networks in place to attract passengers if their prices become less attractive.

The results of section 5 provide an overview of the consumers' airport-airline decision making process, identifying flight-specific parameters, airport-airline interactive parameters, and purely airport characteristics. Estimating elasticities from these parameters, substitutability between airports appears to be higher among the customers of the low cost carriers, who may turn to the large hub airports supported by the trunk carriers when their low fares are no longer so attractive. In all cases, substitution to the outside good (that is, consumers choosing not to fly) in response to a hypothetical price increase significantly outweighs substitution patterns within the market.

CHAPTER III

MARKET STRUCTURE AND PRICES: ENTRY, EXIT, AND MERGERS IN U.S. AIRLINE MARKETS

1. Introduction

The US airline industry represents a rapidly changing competitive environment. Over the last 20 years, mergers, alliances, and evolving airline networks have had a considerable impact on market structure. In this chapter, I focus on the how market structure has evolved over time, and its subsequent effects on pricing, and examine these effects at both the firm and market level. The relationship between market structure and prices is a popular topic of study among economists, however, compared to previous studies of market structure and pricing in the airline industry, this is much more comprehensive in scope. By using a twenty year panel of data, I am able to track firms as they enter new markets, exit existing markets, and merge over time. I proceed by developing and estimating a model of airline pricing, and use this, along with measurements of the changes in market structure, to estimate the complete result of these changes in market structure. Additionally, by using a lengthy panel of data, I am able to add additional control for unobserved heterogeneity that have been unavailable in prior studies of the airline industry that have been estimated over a much shorter time horizon.

I investigate the changes in market structure by source and I use a comprehensive model that allows changes over a 20 year period from 1993-2012. This is a longer panel of data than has historically been applied to studies of market structure in the airline industry, which offers us a number of advantages. The longer panel allows us to track many markets over time, a delineation of changes in market structure by source, i.e., entry, exit, and merger[4] as well as changes to how airlines route their passengers through hubbing and codeshare alliances. Finally, I introduce a variety of treatments of unobserved heterogeneity, including no controls, controls for time period, firms, origins, destinations, and, for the market (i.e., origin-destination pairs). These treatments are the most comprehensive treatment of unobserved heterogeneity in the literature.

Estimating the total effect of a change in market structure is done through a two-step procedure. The first step involves running a fixed-effects model of prices, to obtain estimates of the impact of various measures of market structure on prices. Then, in the second step, I use the estimates to calculate the changes in price that accrue from changes in market structure by source i.e., from entry, exit and mergers. There are many cases. Entry and exit are straightforward, but there are many different types of merger effects observed for the same merger. For example, in a particular market both parties to the merger might serve the market; alternatively, an existing firm in the market may merge with another firm that serves other markets but not the market of analysis. And, finally, in any one merger, it is common that in the set of markets, both types of effects are observed. I use the coefficients from the first step to these changes to produce estimates of the total market response to entry, exit, and mergers. The results of this study point to heterogeneity across markets. New entrants tend to offer lower fares, but their impact on concentration varies across markets, with average effects small, but slightly negative. Exiting firms tend to have the opposite effect, increasing concentration slightly, but

[4] The effects of mergers is somewhat complicated in that the change in market structure may be that both firms may appear in an origin-destination market, one firm appears in a particular market and the other in another market, firms may change identity, etc. My approach makes a distinction between these types of mergers at that origin-destination level and allows the effects of different types of merging effects to be identified.

again, this effect displays much variation between markets. Mergers also have mixed impact on pricing. On average, they have little impact on market concentration, and in some cases, merged firms offer lower prices than they otherwise were expected to, likely as a result of efficiency gains, but in other cases it appears that the increased market power effect dominates, and prices rise.

2. Background

There is a long history of studying the price effects of market structure in the US airline industry, and this paper aims to extend that research. Graham, Kaplan, and Sibley (1983) present one of the first analyses of market concentration and contestability in the airline industry, and find evidence that fares increase with market concentration, and decrease as more firms enter. Morrison and Winston (1987) extend the analysis of market contestability and their results support the supposition that airline markets are not perfectly contestable, and that issues of concentration, number of competing firms, and new entrants are all highly relevant to market pricing.

Studies focusing on mergers in the airline industry include Borenstein (1990) and Kim and Singal (1993), who take separate approaches to address the role that mergers play in market power. Borenstein looks at just two mergers in particular, and only flights connected to one of the merging firm's hubs. He finds substantial increases in market power after these mergers have taken place. Kim and Singal (1993) attempt to look at air fares as a whole, by looking at average changes across markets in which a merger took place. For markets where a merging firm was present, they construct a control group—a market of similar distance with no presence from either of the merging firms. They compare the difference in the average fares between these two groups, and find significant fare increases between the pre and post-merger time periods. In contrast to the work of Kim and Singal, in this paper I use a longer panel of data, which allows for the introduction of market fixed effects. These ideally control for any unobserved heterogeneity between markets. Though Kim and Singal attempt to address this problem by segmenting markets into distance groups, they fail to address other differences between markets besides distance. Kim and Singal also aggregate across firms, whereas the panel data approach I do in this paper allows us to control for firm heterogeneity.

Kwoka and Shumilkina (2010) look at the effects of a single merger between US Airways and Piedmont Air, examining the pricing effects that occur in those markets. They find significant increases in price in response to the merger. Perhaps more importantly, they distinguish between the cases when the merger consolidated the two firms in a single market, and the cases when the merger eliminated a potential entrant. They find prices increase more when the firms are consolidated within a market, but there are still significant price increases along routes where one of the two merging firms was a potential entrant. To maintain consistency with this finding, I will distinguish in this paper between mergers within markets and mergers across markets, in order to account for the differential price effects.

I take a non-structural approach to analyze the role that changes in market structure play in the airline industry. Peters (2006) presents an analysis of the performance of merger simulations. He employs several different structural models of airline demand and uses them to predict price changes post-merger according to the pre-merger demand parameters and an applied consolidation of firm ownership. The results suggest that, in most cases, the merger simulations underestimate the observed price changes, and perform no better than linear regression models also tested. In addition to the limited accuracy in the models analyzed by Peters, structural models also face computational difficulties with datasets this large, and cannot exploit the panel data as effectively. This panel data approach to studying the airline industry is much like what was done by Whalen (2007). Though that paper, specifically, focuses on the international airline markets, and the anti-competitive effects of codesharing, and antitrust immunity. Similar to this study, it benefits from a long panel of data in analyzing airline markets. The panel data allows the author to control for unobserved route-effects and in doing so, finds price-effect estimates for codesharing and antitrust immunity that are smaller than those found using only cross-sectional data, such as Brueckner and Whalen (2000) and Brueckner (2003).

3. Model

I model the average price of an origin-destination-airline triple as a function of specific characteristics, market-level characteristics, and time, firm, and market controls. The model's foundation is in a standard profit-maximizing condition, where price (*P*) is the product of a marginal cost (MC) and markup term (*M*). Estimated in logs, I get an estimation equation for this model, with price as the dependent variable, and variables on the right hand side that determine the cost and markup terms. Because the primary focus of the model is to explain how market structure impacts prices, I use fixed-effect controls to account for as much of cost and demand parameters as possible, leaving only market structure left to be explained by the data. By using panel data, I are able to account for the bulk of these using three key fixed effects. The first are market-specific dummy variables. These should account for any unobserved differences in cost or demand between markets, including commonly used attributes in airline studies such as distance, income, population, and tourist destinations. The airline fixed effects help control for differences of cost and service between the airlines—particularly relevant are the distinctions between the legacy carriers, the low cost carriers, and the regional carriers. Finally, the time fixed effects are used to control for a variety of time-varying factors that may affect costs (fuel prices, security regulations, labor costs), and demand (seasonal fluctuations, global economic conditions).

There are several other controls included in the study that the fixed effects do not capture. Firm-market-time specific variables include the variables to capture distance, direct service, and whether there is a difference between the ticketing and operating airlines, which all account for consumers' willingness to pay for different flight routing. Other studies have consistently shown that consumers are willing to pay more for direct flights, and prefer shorter routing, so the coefficients on the first two variables are expected to be negative. It is unclear, a priori, to what extent the prevalence of code sharing affects fares.

The model includes a variety of explanatory variables to reflect price differences. The first group of variables is those that are constant across the market-time level. These include the number of firms in a market, and the Herfindahl index. Most theories of market structure have prices increasing with market concentration, and decreasing with the number of competing firms. This effect is expected, at least until entry reaches a critical number of firms, such as observed in Bresnahan and Reiss (1991). The number of firms in the market, as measured in this study, is computed by counting the number of firms present at both the origin and destination airport. This is preferable to counting the number of firms observed serving in the data in smaller markets because of sampling problems. Furthermore, due to the construction of most airlines' hub-and-spoke networks, service can be offered without an explicit entry decision by the firm. Nonetheless, it is possible that not all firms counted actually do offer service in the market, and as such, this variable accounts for both actual, and potential, competition.

Additionally, at the market-time level, I include a count of the total number of mergers that have occurred in a market over the sample period, which may account for price changes by rival firms in response to a merger in the market.

I also include firm-market-time specific determinants of market structure, which include dummies for entry and exit. The expected signs for these are uncertain. New entrants may offer lower prices to try to grow market share or, alternatively, the entry decision may be endogenous, and they only enter when prices are high. Of particular interest is how this entry variable changes if a firm enters a market via merger, rather than entering directly.

The model estimated is takes the form:

$$fare_{ijt} = \beta_1 X_j + \beta_2 X_{jt} + \beta_3 X_{ijt} + \beta_4 X_t + \beta_5 X_i + \beta_6 * m_{itn} * X^*_{ijt} + \varepsilon_{ijt}$$

Where i indexes airlines, j indexes markets, and t indexes time, and n indexes mergers. Here, X_j are the market fixed effects; X_{jt} include the Herfindahl index, number of firms, and number of mergers; X_{ijt} include the firm specific price controls, entry, and exit variables; X_t and X_i are the time and firm dummies, respectively, while m_{itn} are firm merger dummies; X^*_{ijt} are a subset of variables interacted with mergers, including entry, exit, and consolidation dummies. Within this framework, I perform a number of different specifications, and robustness checks.

4. Data Sources and Variables

The primary data for this study comes from the US Bureau of Transportation Statistics' (BTS) Airline Origin and Destination Survey (DB1B). These data are compiled quarterly, and represent a 10% sample of reporting tickets sold for domestic air travel. This study uses the DB1B Market data, which contains directional, market-specific data for each itinerary in the data.

The data are available on a quarterly basis from 1993 through 2012. I limit the data using a variety of methods. First, I use only routes flown within the contiguous United States. I drop the top and bottom 5% of all fares, as these are most likely to contain data errors, as well as any flight requiring more than four connections was dropped; such filters are common in studies of the airline industry. I further limit the data to the top 100 origin and destination airports, as ranked by total passengers over the entirety of the sample period. These 100 airports encompass over 90% of the total passenger volume for US domestic air travel. In my analysis, a market is defined as a directional origin-destination airport pair.[5] With 100 airports, there is the potential for up to 20,000 distinct markets, however, due to limited demand (either very small markets, or airports that both serve the same geographical region), not every potential market is realized. I limit my study to only the origin-destination pairs for which there are observations in all 80 quarters, resulting in a total of 8,320 markets observed. Air

[5] There has been some discussion in the literature as to whether analysis should be done by airport pair or by city pair. Though this paper presents analysis done by airport pair, I have repeated the analysis using city pairs instead, and found the results to be qualitatively identical, and quantitatively similar.

carriers included in the study were limited to US commercial air carriers, who had a sample of at least 50 transported in a given time period. This left 55 carriers identified in the data over the course of the sample. Data were averaged by carrier, market, and time, yielding a total of 2,880,822 observations in the data set.

I am primarily interested in the effects of changes in market structure on market outcomes, specifically prices. Observing markets over time, I am able to observe firms enter and exit new markets. Additionally, there are a number of mergers between firms, which impact market structure in several ways, most notably mergers that consolidate two firms within a market, and entry into new markets that occurs through a merger. The information on the mergers for this study comes from Airlines for America, a US-based trade association. In all, there are 18 mergers listed between 1993 and 2010, however, due to insufficient data[6] for some of the smaller airlines, only eight of these mergers were used for the final study. These mergers utilized are presented in Table 6. The act of merging can have differential effects depending on the airline, the merger, and the specific market. In some cases, the merger may represent a consolidation of firms within a market. In others, the merger may be a way for firms to expand their existing networks via acquisition. In most of the merger cases, the two firms become completely consolidated not long after the merger is finalized, however that is not always the case. When Delta Air Lines merged with Comair in 1999, Comair continued operating as a subsidiary of Delta through September 2012. Similarly, after Southwest Airlines and AirTran merged in 2010, flights continued under the name of both airlines.

[6] Several of the merged firms in the data were smaller, regional carriers who did not operate enough flights under their own name to survive the data filters put in place for this study.

Table 6: Airline Mergers

Merger Number	Airline 1	Airline 2	Date Merger Completed
1	Southwest	Morris Airlines	12/31/1993
2	Airtran	ValueJet	11/17/1997
3	American Airlines	Reno Air	2/1/1999
4	American Airlines	TWA	4/9/2001
5	US Airways	America West	9/27/2005
6	Delta	Northwest	12/31/2009
7	United Airlines	Continental	10/1/2010
8	Southwest	Airtran	5/2/2011

The dependent variable is the log of the average of a firm's quarterly fare for a given origin-destination pair, measured in real, 1993[7] dollars. Figure 1 presents real, average fares over time. There is significant seasonal fluctuation apparent in the data, with the highest fares, on average, occurring in quarter 1, and the lowest fares occurring in quarter 3. Accounting for these seasonal fluctuations, fares display a downward trend through the early 2000s, and then appear to head upward again in more recent years. Naturally, price changes can be caused by demand fluctuations, as well as exogenously determined cost factors, such as fuel prices, but there are also significant shifts in market structure (see Figure 2) occurring over the time period, and so it is the objective of this paper to attempt to identify how much of these long-term price fluctuations might be determined by market structure.

[7] This corresponds to the earliest time period available in the data. Nominal fares were deflated using the consumer pricing index (CPI) as made available by the Bureau of Labor Statistics (BLS).

Figure 1: Average Fares over Time

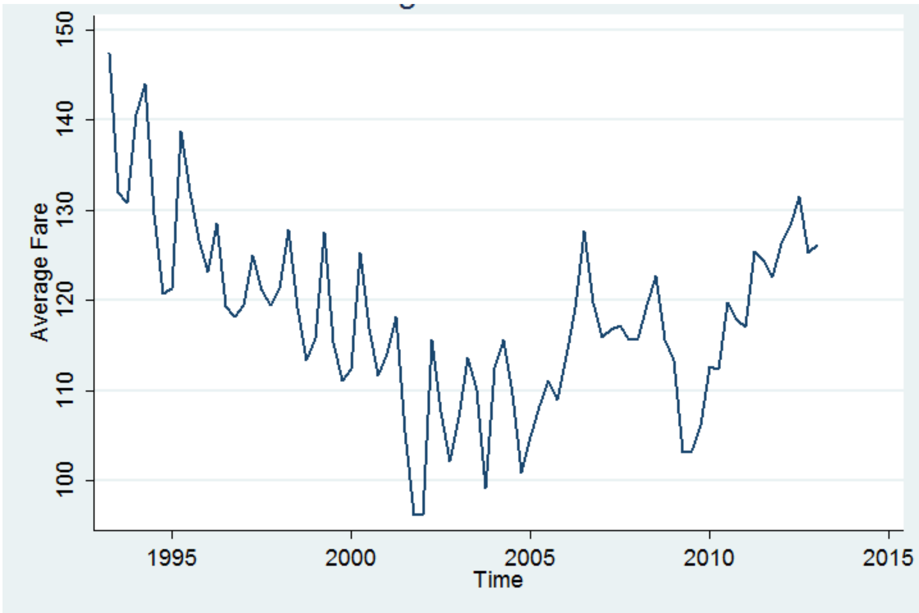
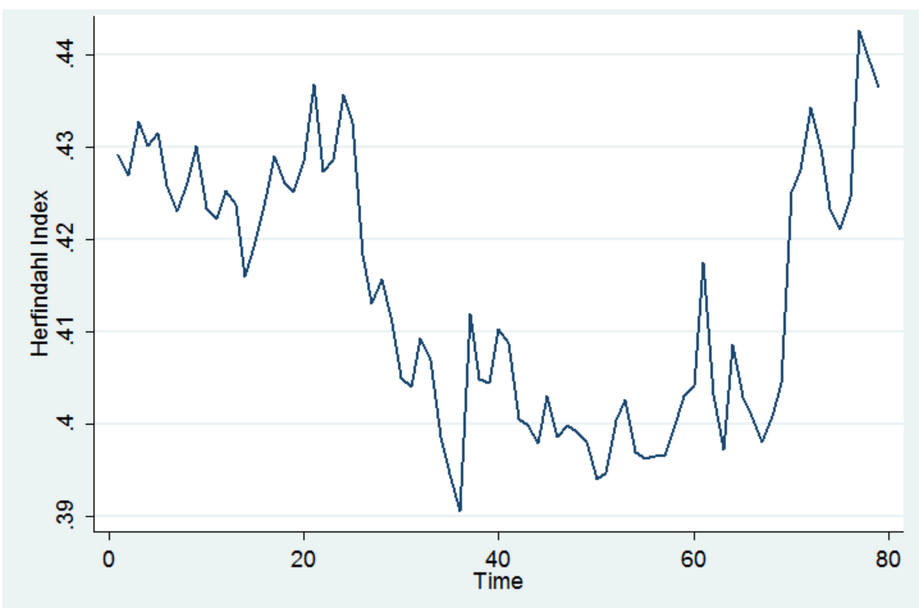


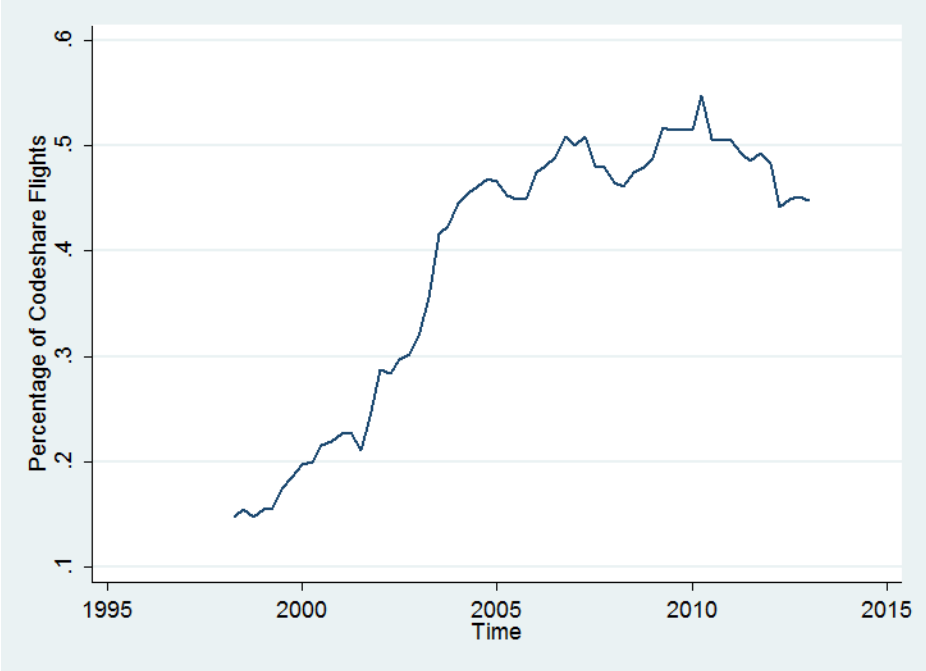
Figure 2: Market Concentration over Time



The explanatory variables in the data are divided into three categories. The first category is the firm-market specific variables. Average distance is the average distance, in miles, for a carrier's flights serving a given market. Though the total distance between two airports remains fixed, this number represents the total flight distance covered, including all connecting flights. This number will vary both between carriers and within carriers over time, as they adjust how they route their flights. Another variable capturing a similar feature is the proportion of firms' flights that are direct or not. This, combined with the average distance will account for both whether or not the flight is direct and, if they're not, how much extra distance is accumulated because of the routing. A final firm-specific variable included is the share of a firm's ticketed flights that are carried out by another airline. Though code sharing information is not available prior to 1998, in the years since, it has grown increasingly popular, particularly in smaller markets, as the larger airlines rely on the cost-savings of regional carriers to transport their passengers. Figure 3 below presents the average share of codesharing along routes over time.

Identifying entry and exit into markets is not immediately straightforward. Due to limited sampling, and limited demand for travel in smaller markets, not every firm shows up in the data every quarter, even if they offer continual service. Thus, to try to better identify when a new firm has entered a market, I define an entry into a market as a firm having an observation in the particular origin-destination pair when it did not record any observations the previous time period, and the firm offers new service at one of the market endpoints when it did not serve any markets from that endpoint in the preceding time period. Thus, a firm is "in" a market if it has a presence at both endpoints, regardless of whether or not there are any records of passengers actually being transported in the sample. It is reasonable, in many cases, that so long as a firm has a presence at both the origin and destination airports, it is possible for the airline to make the connection over their network. Because it may be the case that new entrants pricing behavior changes over time (that is, the effects of being "new" wear off), I include two variables to measure entry effects. The first is a dummy taking the value 1 for all time periods after entry has occurred and 0 otherwise. The other takes a value 0 prior to entry and t/(1+t) after entry, to allow for an adjustment. The long-run effect is the sum of the two coefficients. Similar to the entry variable, there is also a variable for exit, which represents a firm offering service when it does not do so in the following time period (both along the route, and at one of the two endpoints).

Figure 3: Codeshare Utilization over Time



The final set of variables is the set of variables representing mergers. For each of the eight mergers involved in this study, I have three dummy variables. The first is a simple dummy variable for each of the firms after the merger. I then add two additional market-specific dummy variables to capture special features of the merger. The first of these two is a dummy variable indicating if the merger consolidated two firms within the market. The second is an indicator variable capturing whether or not the firm entered a new market that had previously been served by the firm it merged with, that is indicating expansion via merger, rather than consolidation. There is also one final merger variable included, that is market-level, rather than firm level, and that is an indicator for the number of mergers the market has experienced. This is designed to capture the potential response of competing firms to a rival's merger.

Summary statistics of all the variables are presented in Table 7 below.

Table 7: Summary Statistics

Variable	Mean	Std Dev	Min	Max
Average Air Fare ($)	118.25	48.11	15.81	570
Average Distance (Miles)	1398.88	617.67	286	2777
Direct Flights (%)	0.1156	0.2709	0	1
Codeshared Flights (%)	0.2917	0.382	0	1
Herfindahl Index	0.0146	0.0356	0.000082	1

5. Results

The results section is broken up into several subsections. Section 5.1 presents an overview of the regression results, and a discussion of the model selection. Section 5.2 provides an analysis of the firm-level effects of entry, exit, and mergers; that is, the price effects of the firms taking the action. Section 5.3 analyzes the market-level effects; how entry, exit, and mergers affect the overall competitive landscape of the market. Section 5.4 presents an aggregation of the firm and market-level effects to try to summarize the total effect of these market-changing outcomes.

5.1. Regression Results

In Table 8, I present regression results. The five columns each represent different specifications, with Column 1 representing the most basic specification, and each subsequent column adding additional fixed effects to the model. The first column presents the base model without any of the fixed-effects. I begin by comparing the column-by-column results, both in terms of overall fit, and in terms of the individual coefficient estimates in order to identify the best model with which to proceed. For the sake of space constraints, the values of these merger variables are suppressed in Table 8, however, they are present in each of Columns 1-5, and will be presented and discussed in greater detail in the following sections.

Table 8: Regression Results

VARIABLES	(1) Fare	(2) Fare	(3) Fare	(4) Fare	(5) Fare
Distance (Miles)	0.166***	0.171***	0.169***	0.278***	0.211***
	(0.000689)	(0.000671)	(0.000669)	(0.000775)	(0.00150)
Herfindahl	0.0634***	0.0533***	0.0425***	0.0261***	0.0695***
	(0.000581)	(0.000569)	(0.000559)	(0.000591)	(0.000760)
Direct (%)	-0.632***	-0.679***	-0.759***	-0.554***	-0.733***
	(0.0105)	(0.0102)	(0.0101)	(0.00971)	(0.0104)
Direct x Distance	0.00495***	0.0138***	0.0273***	0.0130***	0.0395***
	(0.00154)	(0.00149)	(0.00147)	(0.00142)	(0.00151)
Codeshared (%)	0.797***	0.855***	0.823***	0.794***	0.376***
	(0.00850)	(0.00829)	(0.00814)	(0.00783)	(0.00774)
Codeshare x Distance	-0.0832***	-0.0841***	-0.0911***	-0.101***	-0.0401***
	(0.00121)	(0.00118)	(0.00116)	(0.00111)	(0.00110)
Entry (Immediate)	0.414***	-0.403***	-0.00766	-0.0673***	-0.0829***
	(0.00335)	(0.00512)	(0.00526)	(0.00499)	(0.00473)
Entry (Adjustment)	-0.395***	0.498***	-0.0186***	0.0511***	0.0683***

	(0.00315)	(0.00529)	(0.00561)	(0.00533)	(0.00506)
Firm about to Exit	0.0568***	0.0199***	0.0651***	0.0430***	0.0388***
	(0.00174)	(0.00262)	(0.00263)	(0.00249)	(0.00235)
Constant	3.568***	3.953***	4.048***	3.169***	3.593***
	(0.00512)	(0.00579)	(0.372)	(0.352)	(0.332)
Observations	2880822	2880822	2880822	2880822	2880822
R-squared	0.220	0.262	0.296	0.371	0.441
Merger Variables	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	Yes	Yes	Yes	Yes
Firm Fixed Effects	No	No	Yes	Yes	Yes
O & D Fixed Effects	No	No	No	Yes	No
O-D Fixed Effects	No	No	No	No	Yes
F-Statistic	1891	2074	2581	1743	89.55
P-Value	0	0	0	0	0

The first set of variables, average distance, share of direct flights, share of codeshare flights, and an interaction between the latter two and would be expected to have a dual effect on prices. Generally speaking, large, at-capacity flights would have the lowest cost per-passenger, however, in smaller markets, there may be insufficient demand to fill such flights, and so airlines will use connecting flights, or outsource from an allied firm in order to capitalize on economies of density and lower costs. Conversely, in some cases, the extra distance, and connections made, might actually raise the cost of offering indirect service. In terms of the demand-determinants of fare, studies have consistently shown that consumers are willing to pay a premium for direct flights. By interacting these two variables (direct flights, and codesharing), I hope to identify that the tradeoffs between the various cost and demand effects might vary by distance. In the base model, the direct coefficient is negative, as well as the interaction with distance, such that the effect is magnified over markets that are farther apart. The codeshare variable is positive, but its interaction with distance is negative, suggesting that the cost-savings of codeshare alliances only become relevant for farther markets.

Examining market structure, I find that the Herfindahl index, which enters in logs, predictably has a positive effect on prices, which is consistent with past studies. The entry variable shows a short-term increase in prices, though allowing for the adjustment over time, it appears to approach 0 in the long run. Column 2 introduces the time fixed effects, which significantly improves the fit of the model (again, an F-test rejects the exclusion of the time dummies). As could be seen in Figure 1 earlier, fares show significant fluctuations over time, including distinct seasonal effects, so it is natural to expect that their inclusion would improve the model.

With the addition of air carrier fixed effects in Column 3, the estimated coefficients remain remarkably stable, but it is notable that the interaction between direct share and distance becomes positive, indicating that customers are willing to pay extra for a direct flight when the distance traveled is greater. This column also induces a number of changes in the merger coefficients, as would be expected, since they are firm-specific across markets, and many of these merger dummies would be expected to pick up firm-specific fixed effects when those weren't explicitly in the model. Column 4 introduces origin and destination fixed effects, but again, there are no drastic changes in the estimated coefficients. The fit of the model has improved, and an F-test for the newly added market controls rejects their exclusion, but the estimated coefficients remain stable.

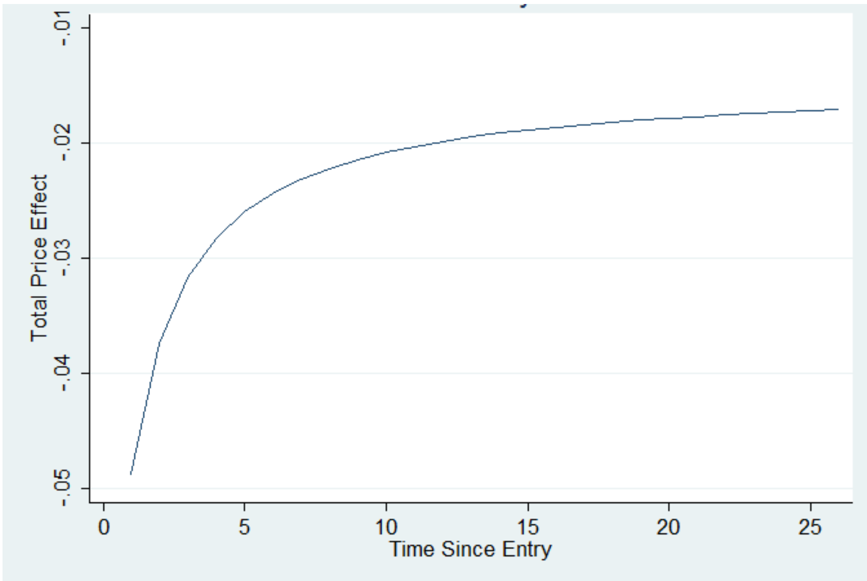
Finally, Column 5 presents the full model with origin-destination fixed effects replacing the separate origin and destination fixed effects. This has, predictably, induced the largest increase in model fit, with the R-squared number increasing from 0.371 with separate origin and destination fixed effects, to 0.441 with origin-destination fixed effects. The bulk of the estimated coefficients have remained stable through the different iterations of fixed effects, though the magnitudes of those that are fixed across markets have naturally decreased. Due to the overall stability of the different models, and the improvements in fit from the added market controls, this will be the model chosen to perform the more in-depth analysis.

5.2. Firm Effects

I now focus specifically on the pricing effects of changes in market structure. When an event (entry, exit, merger) takes place, there are two classes of effects to consider, there is the effect this has on the firm's own behavior (e.g. how a firm changes its pricing behavior after a merger), and there is the effect that it has on the market conditions (e.g. how the merger changes market concentration, and its subsequent effect of firm pricing). I now examine the firm-specific effect in each of the cases.

Looking first at new entry, the regression coefficient is negative, indicating that new entrants offer a price that is below what would otherwise be expected. This effect is likely explained by firms offering lower fares to gain traction in the market. Over time, as evidenced by the Entry Adjustment coefficient, firms then gradually increase their prices as they assimilate into the market. Figure 4 presents a graphical representation of this effect. Conversely to new entrants, exiting firms cannot be observed after they exit the market, so the Exit coefficient from the regression represents a price effect from the period immediately preceding the exit. This is positive, and statistically significant, though it is not apparent whether firms are exiting because they are unable to compete on price, or firms raise their prices, knowing they are about to exit.

Figure 4: Price Effect of Entry over Time



The analysis of mergers is more complex. Separate coefficients are estimated for each of the eight mergers, and for each merger, I consider both the cases where the merger consolidates firms in the market, and when firms enter the market as a result of the merger. Table 9 presents the merger coefficients from the regression presented in Column 5 of Table 8 (the model with the complete set of origin-destination fixed effects). As can be seen in the table, the effects of mergers vary widely. In markets where the mergers consolidate firms, the effects range from -0.035 in the case of the Delta-Northwest merger, to 0.135 for the Airtran-ValueJet merger. Of the four largest mergers, two of them, American-TWA, and Delta-Northwest have negative coefficients, while the other two, US Airways-America West and United-Continental have positive coefficients. In terms of the competing effects of mergers (increased market power vs economies of scale and cost savings), there does not appear to be a clear effect that wins out.

In analyzing entry via mergers, as was noted in the analysis of the previous section, the immediate coefficient on entry was a drop in fares that gradually increased over time, suggesting a long-run effect of -0.015, or a 1.5% reduced fare. If firms, however, enter a market as a result of a merger, this effect is modified. The first three mergers in the study feature very few of these occurrences, so I will not analyze those results in detail, however, in the remaining five, there once again appears to be varied results, with a negative and significant coefficient in two of the cases, a positive and significant coefficient in two of the cases, and a third coefficient that is not statistically significant. The estimated effect for the American-TWA merger is much larger, 0.26, indicating a 26% fare increase. This merger was, however, somewhat different than the others as TWA had already filed for bankruptcy. For the merger between United and Continental Airlines, the results indicate an additional 3.5% drop in fares in their new markets served, while Delta-Northwest featured a 7% increase.

Table 9: Merger Coefficient Estimates

	Consolidating Mergers		Entry Via Merger	
	Incidents	Coefficient	Incidents	Coefficient
Merger: Southwest-Morris	3	0.0780	3	0.176**
		(0.0751)		(0.0786)
Merger: Airtran-ValueJet	5	0.135**	5	-0.0674
		(0.0549)		(0.0579)
Merger: American-RenoAir	80	0.0371***	3	-0.132
		(0.00532)		(0.167)
Merger: American-TWA	2677	-0.0196***	271	0.256***
		(0.00113)		(0.0197)
Merger: USAir-AmericaWest	2169	0.0642***	427	0.0140
		(0.00117)		(0.0101)
Merger: Delta-Northwest	4681	-0.0350***	322	0.0721***
		(0.00142)		(0.0175)
Merger: Southwest-Airtran	933	0.00576***	279	-0.00521
		(0.00170)		(0.0152)
Merger: United-Continental	5522	0.00459***	541	-0.0354***
		(0.00142)		(0.00902)

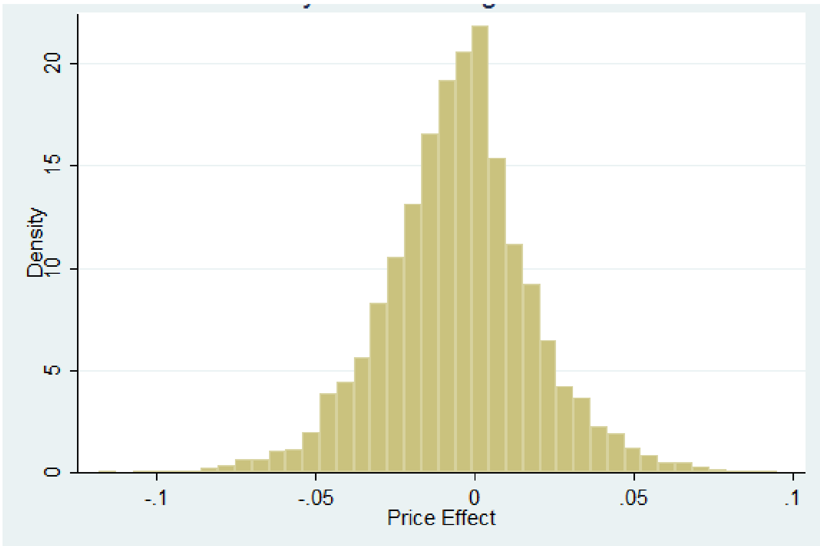
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.3. Market Effects

When firms choose to enter, exit, or consolidate within a market, they not only have an effect on their own pricing behavior, but potentially an effect on their rivals' pricing behavior. The most natural way this manifests itself is through changes to market concentration. When a new firm enters a market, this would be expected to reduce concentration in the market and result in lower fares, even if new entrants don't price any differently. Similarly, a merger that consolidates firms in the market would be expected to increase concentration, and raise fares market-wide.

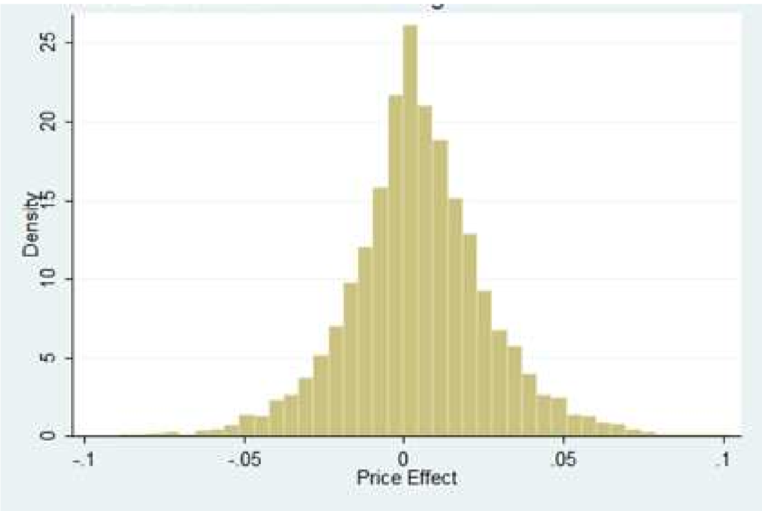
I look first at entry and exit, and their effect on market concentration, as measured in this study by the Herfindahl Index. The changes in market concentration vary widely from market-to-market, and cannot be completely isolated, so to attempt to measure this change, I look at the difference in concentration from one year prior, to one year after the event. This, ideally, provides sufficient time for the markets to stabilize in response to the change. By looking at the change in market concentration, I compute the predicted price effect by multiplying the change in the logged Herfindahl index by the regression coefficient from Table 8, Column 5 above. Figure 5 below presents a histogram of the predicted price effect occurring from entry.

Figure 5: Price Effect of Entry Due to Change in Market Concentration



The price effects of entry are, on average, slightly negative, with new entrants reducing concentration in the market, but range, at the extremes from approximately -10% to 10%. Again, these effects do not completely control for other changes in market structure, so some of the outliers may be more representative of coincidental changes in market structure, however, the average of a small, slightly negative effect on concentration would be consistent with theoretical expectations. Examining exits in the market, it displays a similar, but converse market response, with a small, but slightly positive change to concentration and pricing, with comparable dispersion. Figure 6, below, displays a histogram of price effects due to firms exiting a market.

Figure 6: Price Effect of Exit Due to Change in Market Concentration



Mergers (at least those mergers with sufficiently many observations, display a similar pattern of dispersion, with Figure 7 below, presenting a representative example from the Delta-Northwest merger. Again, there is high variation between markets, with, on average, a slightly positive effect.

Figure 7: Price Effect of Delta-Northwest Merger Due to Change in Market Concentration

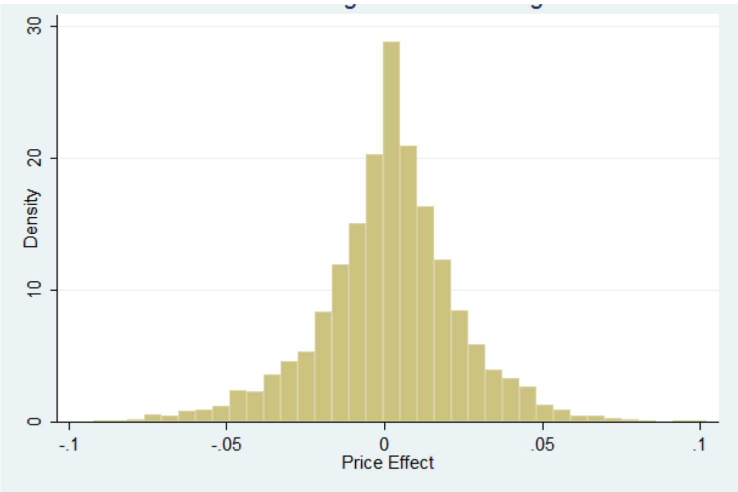


Table 10 presents a summary of these price effects, for all the mergers, in addition to entry and exit. In most cases the average effect is small, predicting less than 1% change in price as a result of the change, but the variance is high. This is to be expected, as a small firm entering a large market would impact market structure much differently than a large firm entering a small market. Despite the high variance, the average effects do coincide, in many ways, with expectations. New entrants tend to push down prices, while firms exiting tend to raise prices. There is more variation amongst mergers, with no consistent pattern to the sign of the effect. Though the variation is high across markets, in all but the Southwest-Morris, American-Reno Air, and United-Continental mergers, the null hypothesis that the mean effect is 0 can be rejected at the 5% level.

Table 10: Price Effects Due to Change in Market Concentration

Event	Mean Price Effect	Standard Deviation	Min	Max
Entry	-0.0049***	0.023	-0.118	0.095
Exit	0.0045***	0.022	-0.089	0.102
Merger: Southwest-Morris	-0.002	0.021	-0.099	0.087
Merger: Airtran-ValueJet	-0.0199**	0.039	-0.062	0.020
Merger: American-RenoAir	-0.001	0.022	-0.063	0.048
Merger: American-TWA	0.0046***	0.020	-0.076	0.087
Merger: USAir-AmericaWest	-0.0022***	0.021	-0.099	0.087
Merger: Delta-Northwest	0.0015***	0.023	-0.092	0.102
Merger: Southwest-Airtran	0.0037***	0.019	-0.087	0.082
Merger: United-Continental	0.0005	0.021	-0.106	0.093

*** p<0.01, ** p<0.05, * p<0.1

In addition to the price effects caused by the change in market concentration, the regression results also find a regression coefficient of 0.0153 (0.0006) for the price response from firms in a market to a rivals merger. Thus, even if mergers do not negatively impact concentration, the reduction in the number of firms in the market may still harm competition.

5.4. Cumulative Results

The total impact of firms entering, exiting, or consolidating in a market is the cumulative effect of the firm-level effects, and the market-level effects. Table 11 summarizes the mean cumulative effects of such events occurring. As one might expect, new entrants have a negative effect on prices, both for the firm entering, and in terms of the effect it has making markets more competitive. Exiting firms have a small effect making markets less competitive, and a much larger price effect just before they exit (again, it is unclear whether this is the cause or effect of the exit). Mergers show more varied behavior, largely reducing competition and raising fares market-wide, however in several of the mergers, the firm-level price effect is negatively, likely as a result of efficiency gains, and so, on average, one might expect prices to stay the same or fall for the firm post-merger. This appears to be the case for the American-TWA merger, and the Delta-Northwest merger.

Table 11: Cumulative Effects

Event	Market-Level Effect	Firm-Level Effect	Cumulative Effect
Entry	-0.005	-0.015	-0.020
Exit	0.005	0.039	0.043
Merger: Southwest-Morris	0.013	0.078	0.091
Merger: Airtran-ValueJet	-0.005	0.135	0.130
Merger: American-RenoAir	0.014	0.037	0.051
Merger: American-TWA	0.020	-0.020	0.000
Merger: USAir-AmericaWest	0.013	0.064	0.077
Merger: Delta-Northwest	0.017	-0.035	-0.018
Merger: Southwest-Airtran	0.019	0.006	0.025
Merger: United-Continental	0.016	0.005	0.020

6. Conclusion

In this study, I analyzed how market pricing responds to changes in structure, particularly in response to market-changing events such as mergers, entry and exit. By utilizing panel data, and including fixed-effects controls, I believe these estimates are an improvement over past analyses, and I are able to examine the industry more comprehensively. Over the last 20 years, the US airline industry has seen a number of mergers, including those involving some of its biggest firms. Such consolidation would potentially be a threat to competitive forces, and may be responsible for higher fares. In my analysis, I find that there is large variation in the effects of mergers across markets, with the average effects being mixed, though, in most cases quite small (predicted market fare increases of 2% or less). In some of the cases, even where the market becomes significantly more consolidated as a result of the merger, the merged firm will offer lower fares, likely as the result of increased efficiency.

By using a larger data I have used a larger data set than has been traditionally used to analyze changes in market structure in the airline industry, and perhaps the strongest conclusion that can be made is that there is a lot of variation in the price response when the composition of the market changes. This is intuitively reasonable, as one would not expect a new entrant to the largest markets to have the same impact as new entrants in the smallest markets, and the data support that. Similarly, though mergers can be worrisome to policymakers, in terms of controlling market power, they do not always yield higher prices, and when they do, the magnitudes are rarely particularly large.

CHAPTER IV

ENTRY AND EXIT IN NETWORKED INDUSTRIES: A STUDY OF AIRLINE MARKETS

1. Introduction

Since at least Bain (1956), it has been well established that there is a strong connection between entry conditions and market performance. Entry conditions affect the number of firms present in the market and may also affect how firms react to the threat of potential competition.[8] Virtually all studies of market entry and exit focus on markets in isolation, however, in some industries, firms' entry decisions may be interdependent between markets. When firms operate over a network, their different locations are explicitly connected via their service, and so it is only natural that the entry decisions are connected as well. In this paper, I develop a model of entry and exit in networked industries, and use it to analyze firms decisions in the U.S. airline industry.

The competitive environment of the U.S. airline industry has been the topic of much research throughout the past 30 years. The deregulation of the industry in 1978 spawned a lot of competitive analysis, and with a number of high-profile bankruptcies and mergers in recent years, the industry remains a popular focus of research. A number of papers specifically focus on entry and exit decisions in the industry. These works

---

[8] There is a long history of research on entry, and its effects on competition, all of which would be too numerous to list. For some background on the subject, see, for example, Baumol, Panzar, and Willig (1982), Dunne, Roberts, Samuelson (1988), and Geroski (1995). For work specific to the airline industry, see, for example, Whinston and Collins (1992). Joskow, Werden, and Johnson (1994), and Morrison and Winston (1990).

include Reiss and Spiller (1989), Morrison and Winston (1990), Berry (1992), Sinclair (1995), and more recently Ciliberto and Tamer (2009), to name just a few of the more prominent examples. When modeling firm entry decisions, these papers incorporate the effects of the firms' networks in a variety of ways. For example, Morrison and Winston (1990), in their probit model of firm entry, incorporate the firm's market share at the origin and destination airports. Berry (1992), additionally, includes the number of routes served from the endpoints. Sinclair (1995) utilizes a number of variables to capturing an airline's hub characteristics of an airport in order to account for the network effects. Though these papers consistently find evidence that an airline's network characteristics affect entry decisions, network effects are always included non-structurally. What sets my work apart is that, in this paper, I explicitly model the network as part of the process. Additionally, all the prior literature models entry and exit at the route-level (that is, the decision to offer service between airports), where as in this paper, I model entry and exit at the airport level (whether or not the firm is present at an airport). It is this choice of airports that defines the firms' network; stated otherwise, I focus on entry into the nodes of the network rather than the links. Airlines operate over networks, and their entry and exit decisions at the origin-destination level cannot be made independently. Service along an origin-destination pair requires airport presence as a prerequisite, and the decision to have a presence at an airport is an agglomeration of all the origin-destination pairs that can be served from that airport. It is the decision to enter or exit an airport that is really the crucial decision that firms must make. This is where airlines pay explicit costs to enter (such as gate and runway fees) that are independent of the airlines' specific choices of origin-destination markets to serve. In fact, by utilizing connecting flights and computerized reservation systems, airlines typically need not ever make an explicit choice of which origin-destination markets to serve, so long as they are present at both endpoints. It is for these reasons that in this paper, I model airline entry and exit into and out of airports, rather than particular routes.

The primary innovation of this paper is the examination of entry and exit in the airline industry at the airport level. In order to do this, in the next section, I develop a model of entry into a network, rather than looking at markets in isolation. Over such a network, where profits are generated from the connections between nodes on a network, the incentives to expand are driven by the total number of connecting links that can be made. In the context of the airline industry, this means that firms that are present at more airports will have greater incentive to enter into new airports, as they will have more potential destinations for the customers of that market to choose from, and can potentially profit from each one.

After developing the model of entry and exit over a network, I estimate a discrete choice model of which firm chooses to enter or exit.[9] I find that current network presence plays an important role in entry and exit decisions, as firms with larger networks are both more likely to enter new airports and less likely to exit existing ones. Additionally, I find that geography plays a key role, as firms are much more likely to expand into new airports that are closer to airports they already serve, while such geographic proximity also makes firms much less likely to exit.

[9] Entry into airline markets is different from many other industries, as the activity is almost entirely by existing firms expanding their network, rather than brand new firms. Even in the case of brand new airlines, it is impossible for an airline to serve just a single airport, so it will always be observed as present elsewhere on the network. As such, I utilize an explicit choice set of only airlines exiting elsewhere on the network. Such restricted choice sets have been used in other studies of airline markets as well, notably Morrison and Winston (1987) who, in their study of contestable markets, considered only potential entry along a route by firms presently serving at least one of the endpoints.

2. Model

I model the problem as a two-stage game where, in the first stage, firms choose whether or not to offer service in the market, and in the second stage, firms that are present in the market compete and receive profits. The total set of firms can be divided into incumbents and potential entrants, with incumbents choosing whether to stay in the market or exit, and potential entrants choosing to enter the market or remain out. There are separate fixed costs associated with each choice, and firms make their decisions to enter/exit/remain in order to maximize profits net of the fixed costs.

When firms are present on a particular node of the network, they are able to offer service connecting that node to all other nodes where they have a presence. It is for this connecting service that profits are accrued. Intuitively, the idea behind this model is that when firms decide to enter a new node on a network, they consider the profit that can be generated over all of the links connecting this new node to the firms' preexisting nodes. Firms' entry decisions are based on the aggregation of the link profit over all the new links they can serve, and this total profit is then compared to the fixed costs to determine whether or not it is profitable to serve the market. In this model, I assume that so long as an airline is present at two airports, it offers connecting service between them,[10] though I do not distinguish between direct or indirect service.

For an industry with N total location choices over the network, a firm considering the full set of location decisions would need to consider 2^N possible choices. In the United States alone, there are several hundred airports for airlines to consider. Such a

[10] In the empirical model, I drop airports within 150 miles from this profit aggregation, as the data show very little travel between them, and in major metropolitan areas, there are often several large airports that serve as substitutes to one another, rather than as potential destinations.

decision process would not only be computationally infeasible to estimate as an econometrician, but would also be too complicated for the airlines themselves to compute. Instead, I focus on expansion or contraction by the airlines at the margin, examining each entry or exit decision individually.[11] I approach the problem by looking at airports where entry or exit has occurred, and examining which firm has chosen to do so. Conditional on entry occurring, the firm that enters, amongst a set of firms that do not enter, is the one with the greatest incentive to enter, based upon the accrued profits across all the origin-destination pairs it can serve from that airport. Of the firms in the market the one that decides to exit should have the least incentive to remain in the market, again, based upon the profit of all markets connected to that airport.

I model post-entry profit for an origin-destination pair as being a function of market characteristics, and the number of firms competing on that link. I denote the profit of airline k offering service between airport i and airport j as $\pi_{ijk}(\theta_{ij}, n_{ij})$, where θ_{ij} are the market-specific characteristics, and n_{ij} are the number of firms offering service along that route.

Letting S_k represent the set of all airports where firm k is currently present, the marginal gross profit for firm k from entering market i would be $\sum_{j \in S_k} \pi_{ijk}(\theta_{ij}, n_{ij})$, the aggregation of profits from all the new origin-destination pairs it can serve. Letting F_k^E be the firm's fixed cost of entry into a new airport, the condition for entry for firm k into airport i can be written as

[11] It is reasonable to believe that airlines could consider a small number of changes simultaneously. When multiple entries and/or exits occur in the same time period, though I model the decisions separately, I take into account all of the simultaneous decisions' effects on each other.

$$\sum_{j \in S_k} \pi_{ijk}(\theta_{ij}, n_{ij}) - F_k^E \geq 0 \tag{1}$$

That is, a firm enters when the total profit it can earn from flights to/from the new airport are greater than the cost of entry.

The market incumbent faces a similar problem, but only has to face fixed costs of F_k^I to remain in the market. Thus, the condition for incumbent firm k to exit market i is given by

$$\sum_{j \in S_k} \pi_{ijk}(\theta_{ij}, n_{ij}) - F_k^I \leq 0 \tag{2}$$

To analyze the entry decisions, it is necessary to make a number of simplifying assumptions about the profit functions $\pi_{ijk}(\theta_{ij}, n_{ij})$. Because the number of origin-destination market pairs increases quadratically with the number of airports in the network, there are not enough observations to identify each market's profit function individually.[12] Instead, I estimate a model that is linear in parameters, so that the origin-destination profit functions can be summed, and the estimation can be performed on the summation.

Following Berry (1992), I will assume that competition on an origin-destination pair is Cournot with constant and symmetrical marginal costs. In a Cournot model with linear demand, given by $P = A - BQ$, firm profits are given by $\pi = \frac{(A-MC)^2}{B(n+1)^2}$. As demand and cost parameters are not directly observable, but the number of firms is, profits are approximated by

[12] With 187 airports in the model, there are over 17,000 airport-pairs.

$$\pi_{ijk} = \frac{\theta_{ij}\beta + \varepsilon_{ijk}}{(n_{ij}+1)^2} \tag{3}$$

where θ_{ij} are market characteristics, n_{ij} is the number of firms, and ε_{ij} is a mean 0, i.i.d. normal error term.

Summing these up across markets, the variable profit for firm k entering market i is given by

$$\Pi_{ik}^{v} = \sum_{j \in S_k} \frac{\theta_{ij}\beta + \varepsilon_{ij}}{(n_{ij}+1)^2} = \left(\sum_{j \in S_k} \frac{\theta_{ij}}{(n_{ij}+1)^2}\right)\beta + \sum_{j \in S_k} \varepsilon_{ijk} \tag{4}$$

If the route-level error term, ε_{ijk}, is i.i.d. normal with mean 0 and variance σ^2, then the final sum of error terms can be written as a new error term, v_{ijk} which is also normal, with mean 0 and has variance $(\sum_{j \in S_k} \frac{1}{(n_{ij}+1)^2})\sigma^2$.

The fixed costs associated with being in the market, F_k^E and F_k^I, may also depend on firm characteristics, and are estimated by $F = X_{ik}\lambda + \alpha_{ik}$ where α_i is a mean 0 i.i.d. error term and X_{ik} is a vector of firm-level characteristics.[13] By combining this model of the fixed costs with the estimated variable profit function from Equation (4), the empirical analog of Equations (1) and (2) for firm k entering airport i is given by

$$\Pi_{ik} = \sum_{j \in S_k} \frac{\theta_{ij}\beta + \varepsilon_{ij}}{(n_{ij}+1)^2} + X_{ik}\lambda + \alpha_{ik} + v_{ijk} = \left(\sum_{j \in S_k} \frac{\theta_{ij}}{(n_{ij}+1)^2}\right)\beta + X_{ik}\lambda + \alpha_{ik} + v_{ijk} \tag{5}$$

[13] Note: when estimating the fixed costs of entry, only those factors which would differ between firms can be identified. Thus, while the biggest explicit cost of entry may be airport fees, to the extent that they are identical between firms, they have no effect on relative entry incentives between firms.

If the profit from entering a market is positive (or in the case of exit, when profit from remaining is negative), the firm will choose to enter (exit) the market. Conditional on entry (or exit) occurring, the sole firm that decides to enter among a set of firms that do not must not only be the one firm for which Equation (5) is positive, but by virtue of that fact must also be the firm from the set of potential entrants for which the expression in Equation (5) is maximized. Equivalently, the firm that chooses to exit, among all the firms presently in a market, must be the firm for which the expression in Equation (5) is minimized. When a given airport sees multiple firms enter or exit in the same time period, I construct a separate choice set for each incident; each one containing the entering (or exiting) firm, and all the firms that do not enter (exit).

By framing the problem in this way, I am able to estimate the parameters of this model using a standard discrete choice logistic regression framework. Because of the dual error terms present in Equation (5), to estimate β and λ, I employ mixed multinomial logit model, such as in Revelt and Train (1998), McFadden and Train (2000), and summarized in detail in Train (2003). I used the mixed terms in this regression to account for the aggregated error term, ν_{ijk}.

For each airport when entry occurs, I denote the set of potential entrants at airport i as A_i^E and the probability that firm k enters market i is equal to the probability that $\Pi_{ik} \geq \Pi_{im} \; \forall \, m \in A_i^E$. If the error term, α_{ij} follows a type I extreme value distribution then the probability of firm k entering market i can be written out as

$$\int \left(\frac{e^{\left(\sum_{j \in S_k} \frac{\theta_{ij}}{(n_{ij}+1)^2}\right)\beta + x_{ik}\lambda + v_{ijk}}}{\sum_{z \in A_i^E} e^{\left(\sum_{j \in S_z} \frac{\theta_{ij}}{(n_{ij}+1)^2}\right)\beta + x_{iz}\lambda + v_{ijz}}} \right) f(v)\,dv \qquad (6)$$

While equivalently, for the exit model, the probability that firm k exits market i is equal to the probability that $-\Pi_{ik} \geq -\Pi_{im} \ \forall\, m \in A_i^I$, which is an equivalent expression to Equation (6), but with the expression from Equation (5) negative. $f(v)$ is the density function of the randomly distributed error term which, as I showed above, is normal with mean 0 and has variance $(\sum_{j \in S_k} \frac{1}{(n_{ij}+1)^2})\sigma^2$, which is a standard application of the mixed logit specification, and can be accounted for by letting the coefficient on the constant term in θ have a random effect. The parameter coefficients, β and λ in equation (5) are computed via maximum simulated likelihood estimation, that is, the parameter chosen to maximize the sum of the log-probabilities across all of the chosen alternatives.

3. Data

The data collected on market entries and exits come from a variety of sources. The primary data, identifying firm presence at airports is done using the Department of Transportation's T-100 Domestic Segment data bank. These data are reported from the airlines, and contain non-stop segment data, including carrier, passenger, freight, service class, capacity, and load factor information, though in this paper, they are primarily used to identify firm presence at an airport.

The data cover a 15 year time period, from 1997 through 2011, and is aggregated quarterly.[14] The firms analyzed are those classified as either National Carriers or Major carriers by the Department of Transportation.[15] A firm is considered to be offering service at an airport if it transports at least 250 passengers to or from a given airport in a given quarter, and is present at at least three airports. With the filters in place, there are 57 firms in the final dataset. A firm is considered to have entered a market if it offers service in one quarter when it hadn't offered service in the previous quarter.[16] Similarly, a firm is considered to have exited if it no longer offers service in one quarter when it had in the prior quarter. I exclude firms that have gone bankrupt, or ceased operations, in name, due to a merger, as those represent exit decisions that are outside of the scope of this paper[17]. The primary focus of this paper is to study firms' incentives to alter their network structure, and so I examine only those firms whose decisions are consistent with continued existence.

Data on population come from the Bureau of Economic Analysis's Regional Economics Account database, and are incorporated by Metropolitan Statistical Area (MSA).[18] The airports in this study are those located within one of the defined MSAs.

[14] The full data set is extended by one quarter on each end, such that entry and exit can be observed in the "first" and "last" time periods.

[15] National Carriers are those firms with annual revenue between $100 million and $1 billion. Major Carriers are firms with annual revenue over $1 billion.

[16] In order to filter out potential data errors or other fluke events, I drop secondary incidents of entry or exit for the same firm at the same airport, occurring within four quarters.

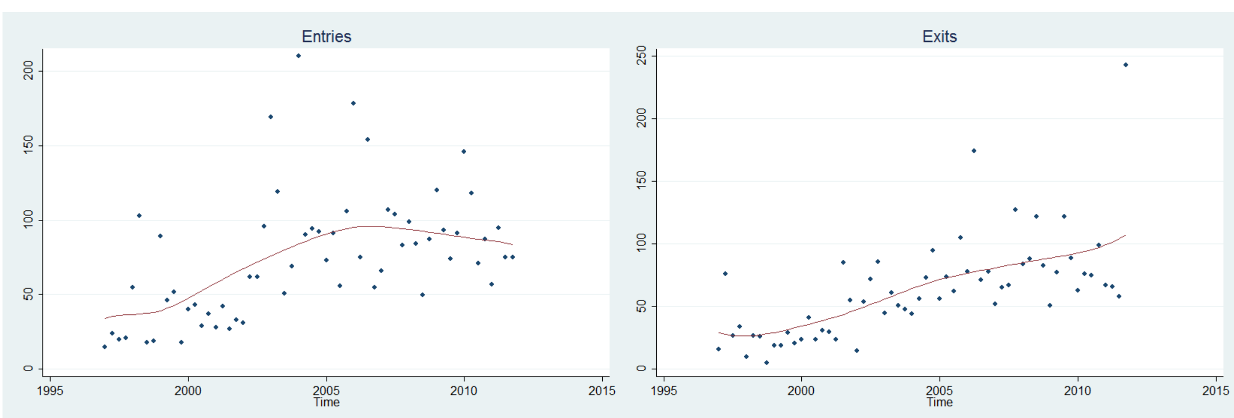
[17] This list includes ValuJet, Reno Air, Atlantic Southeast, Comair, TWA, Shuttle America, America West, ATA, Midwest, Frontier, Continental, and AirTran

[18] Metropolitan Statistical Areas require a core urbanized area of at least 50,000 people, and include adjacent counties that are deemed to have sufficient economic integration.

With these restrictions in place, 187 airports remain in the data. In total, there are 4,474 instances of firm entry and 3,795 instances of firm exit over the 15 year time period.

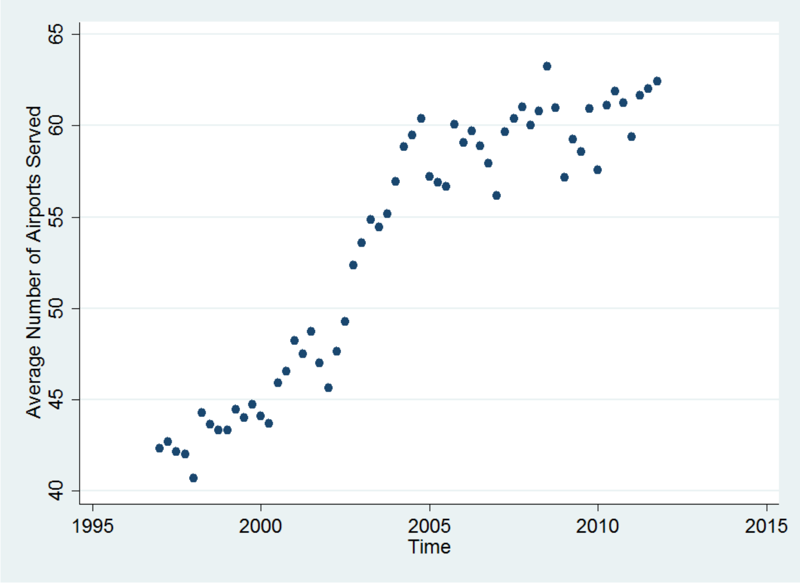
Over time, there has been growth in both airports and firms. Airports have seen a rise in the number of firms operating, increasing from an average of 10 firms per airport in 1997 to over 14 firms per airport in 2011. Over that same time period, the average firm has gone from serving 42 different markets to 62. In my theoretical model, firms' incentive to expand is increasing in the size of their present network, which could potentially explain the trend toward increased network size observed in the data. Figure 8 below presents the total number of entries and exits over time along with a locally weighted regression line. Over time, the number of entries and exits has gradually trended upward. Overall, entries have outpaced exits (though it should be noted that the data exclude mass exits caused by bankruptcies), and exits also display lower variance, but barring a few notable outliers, entries and exits actually follow each other fairly closely.

Figure 8: Entries and Exits over Time



Examining the role this has had on the individual firms, Figure 9 presents the average number of markets served by firms over time. The aggregate effect of all the entry and exit was that firms, on average, expanded their networks. The bulk of this growth came between 2001 and 2005, a time period noted for many high profile bankruptcies, including TWA, United, U.S. Airways, Delta, and Northwest. After 2005, the growth within airlines was much more subdued.

Figure 9: Firm Network Size over Time



For the fixed cost of entry, I include a variable that is the distance from the airline's nearest location to the new market to be entered, as it is likely easier for airlines to enter a new market that is closer to their geographic center of operations, than to add an isolated market on the other side of the country. I also include separate dummies for the carrier's FAA classification (either National Carrier or Major Carrier), acknowledging that their costs may differ.

In order to construct the data used in the estimation procedure, it is necessary to construct separate profit measures for each airport at every point in time. In a market where entry has occurred, the choice set is defined as all airlines that are operating in that time period, but did not offer service to the market in the previous year. For each of the other airports where the airline offers service, the independent variables (constant term, population, population squared, distance, distance squared) are normalized by the number of firms who are also present in each origin-destination market, and then added up by airport, as in Equation (5). These, along with the fixed cost variables make up the complete set of variables in the estimation routine. To estimate the model of firm exit, the independent variables are constructed the same as for entry; however, the choice set is now all the firms who offered service at that airport in the previous time period.

Table 12 presents summary statistics for the firms in the data, segmented by whether or not they were one of the firms that entered/exited a particular market or not. As can be seen from the table, firms that choose to expand tend to have larger networks, serving larger sized markets, and are also located closer geographically. Firms that choose to enter tend to have more rival firms along their routes, which is natural to expect as they tend to be located in larger markets. Conversely, firms that choose to exit a market tend to have smaller networks, serving smaller sized markets, and have fewer rivals along their routes (again, likely due to the fact they serve smaller markets). In all cases, a T-Test rejects the null hypothesis that the means are the same between the two groups.

4. Results

In this section, I present the estimation results. There are three separate specifications, the first of which includes only incidents of entry, the second contains only incidents of firm exit, and the third combines both entry and exit into one model.

Table 12: Summary Statistics

	Firms that Enter	Firms that Don't Enter
Number of Markets	61	43
Avg. Population (in millions)	6.2	5.8
Avg. Distance Between Airports	1,077	1,426
Avg. Number of Rival Firms per Route	8.0	6.4
	Firms that Exit	Firms that Remain
Number of Markets	63	72
Avg. Population (in millions)	6.34	7.74
Avg. Distance Between Airports (miles)	1,097	1,044
Avg. Number of Rival Firms per Route	8.2	9.6

Table 13 presents the results of the random parameter logit estimation for firm entry. The first model presented is the baseline specification, with only the constant term allowed to vary randomly. Examining the coefficient estimates that make up the airport-pair profit function, the constant term is positive and statistically significant—since this is aggregated over all the markets the firm serves, this can be interpreted to mean that firms that serve more markets have increased incentive to enter new markets. The random component on constant term captures the error variance from aggregating across markets. The coefficient on population is negative, which runs counter to expectations, as one would expect that serving more populous markets would give firms more incentive to enter. Though this effect is small compared to the constant term, it is still unexpected, and likely due to correlation with unobserved factors. The distance term is negative, while the distance squared term is positive, indicating that the effect of distance is negative, but with positive concavity.

Table 13: Entry Model Results

VARIABLES	Mean	SD	Mean	SD
Aggregated over Markets (θ)				
Constant	0.307***	-0.000864	0.310***	-0.00133
	(0.0457)	(0.0237)	(0.0459)	(0.0234)
Population	-0.00681***		-0.0111***	-0.0133**
	(0.00247)		(0.00395)	(0.00568)
Distance	-0.460***		-0.460***	
	(0.0570)		(0.0572)	
Distance-Squared	0.0619***		0.0617***	
	(0.0138)		(0.0138)	
Fixed Costs (X)				
Distance to Nearest Airport	-6.565***		-6.575***	
	(0.203)		(0.204)	
Major Carrier	-0.192***		-0.183***	
	(0.0375)		(0.0381)	
Observations	89887	89887	89887	89887

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The components of entry that are not aggregated across markets also play an important role in the entry decision. There is a negative coefficient on the distance to nearest airport coefficient. This coefficient is large, and statistically significant, indicating that geographic proximity is one of the most important factors in the decision to enter new markets. Proximity could affect the cost of entry, as it would be cheaper for airlines to allocate the resources (aircraft, staff, etc.) if the new airport is closer to their existing infrastructure. Finally, the indicator variable for major carriers is negative, indicating that major carriers are less likely to enter new markets, all else being equal, suggesting that larger carriers face greater fixed costs of entry.

Because of the curious results surrounding the coefficient on population, in the second column, population is added to the set of variables that are allowed to vary randomly. In this case, the coefficient on population still takes on a negative, and statistically significant, mean value, but its standard deviation is larger than its mean.

This suggests that the overall effect of population on demand varies greatly by market. This can also be interpreted to say that the true error term from Equation (3) is not i.i.d., but instead has variance that is proportional to the population.

The next set of results is for market exit, and these results are presented in Table 14. Though the entrants and incumbents may not face the exact same profit functions, if they are somewhat consistent, it would be expected that the estimated coefficients for the exit model would be comparable in proportion to the entry model, but opposite in sign. That is, those factors that would make a firm enter a market would also inhibit the firm from exiting a market, and vice versa. Indeed, the results do largely seem to indicate this is the case.

For the first column, only the constant term is included as having a random effect. The coefficient on the constant is negative, and statistically significant, thus indicating that firms with a larger network structure would be less likely to exit (just as firms with a larger network structure were more likely to enter). In this case, population has a negative coefficient, indicating that firms serving larger population markets are less likely to exit. The distance term is positive, with distance-squared negative, indicating the same concavity in terms of the profit function as suggested by the entry equation. The distance to nearest airport term is positive, again, like for market entry, suggesting that geographic proximity plays an important role in exit decisions, and firms are more likely to abandon isolated markets. Though the major carried indicator variable was negative for the entry model, it also is negative for the exit model. Large carriers may face greater fixed costs for entry, but they also reap greater profits once they are in the market, making them less likely to exit.

In the next column, population is added to the list of randomly varying coefficients, and just as it was for the entry model, it is estimated to have a variance as large as its mean, consistent with the notion that the effects of population on profits depends heavily on the particular market.

Table 14: Exit Model Results

VARIABLES	Mean	SD	Mean	SD
Aggregated over Markets (θ)				
Constant	-2.001***	0.723***	-1.997***	0.725***
	(0.0900)	(0.0564)	(0.0906)	(0.0566)
Population	-0.0158***		-0.0304***	0.0420***
	(0.00398)		(0.00657)	(0.00995)
Distance	1.916***		1.934***	
	(0.0991)		(0.0998)	
Distance-Squared	-0.323***		-0.327***	
	(0.0241)		(0.0243)	
Fixed Costs (X)				
Distance to Nearest Airport	1.501***		1.488***	
	(0.177)		(0.179)	
Major Carrier	-0.931***		-0.909***	
	(0.0426)		(0.0434)	
Observations	46037	46037	46037	46037

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The final sets of results, presented in Table 15, are for entry and exit estimated in one single model. If both potential entrants and incumbent firms face the same underlying profit conditions than by combining the two decision-making processes into a single regression model can increase the sample size and thus the accuracy of the estimates. In order to combine these two events, the explanatory variables for the exit model have been made negative prior to pooling the data. Positive coefficients are indicative of greater profit, resulting in increased incentive to enter, and decreased incentive to exit. Negative coefficients are indicative of lower profit, decreased incentive to enter, and increased incentive to exit. Based on the results of the separate models, I separate the indicator variable for major carriers to allow it to differ between the entry and exit model, but all other coefficients are constrained to be the same for both entrants and incumbents. If the parameters truly are the same for entering and exiting firms (that is, if the profits of entrants and incumbents only differs by a linear transformation), then this has the advantage of adding many more observations to the estimation.

Table 15: Entry & Exit Combined Results

VARIABLES	Mean	SD	Mean	SD
Aggregated over Markets (θ)				
Constant	0.682***	-0.00676	0.684***	-0.00681
	(0.0358)	(0.0505)	(0.0360)	(0.0485)
Population	-0.000530		-0.00108	-0.00724
	(0.00166)		(0.00200)	(0.00660)
Distance	-0.825***		-0.828***	
	(0.0430)		(0.0432)	
Distance-Squared	0.135***		0.136***	
	(0.00997)		(0.0100)	
Fixed Costs (X)				
Distance to Nearest Airport	-4.433***		-4.435***	
	(0.128)		(0.128)	
Major Carrier--Entry	-0.172***		-0.171***	
	(0.0360)		(0.0361)	
Major Carrier--Exit	-0.887***		-0.888***	
	(0.0376)		(0.0377)	
Observations	135924	135924	135924	135924

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In this model, the constant coefficient is positive and statistically significant, which is consistent with the prior models. In all cases, firms with a larger network structure show increased incentive to enter a market, and decreased incentive to exit. Distance remains negative, with distance-squared positive, however, in this model, the coefficient on population nor its standard deviation (in the model where it is allowed to vary randomly) are statistically significant—once again indicative of the fact that population appears to be a poor proxy for demand. The distance to nearest airport coefficient is negative, and both the indicator for a major carrier in the entry model and exit model are negative, with the coefficient in the exit model greater in magnitude.

5. Conclusion

Though much work has been done studying market structure in isolated markets, little has been done in the way of analyzing networked markets. This paper develops a model of entry and exit into such markets, and formulates the problem in such a way that makes it econometrically tractable using a standard discrete choice framework. The foundation of the model is that if firms operate over a network, when they expand to a new location, the profitability is determined by the connections they make to the existing locations in their network, and those firms with a larger network, all else being equal, will have greater incentive to expand. I estimate the model by examining firm entry choice at an airport, and by utilizing a parameterized profit function, I am able to estimate the coefficients of the route-level profit function from the aggregated data.

When this model is applied to the U.S. airline industry, I find strong evidence that the breadth of a firm's network plays an important role in its decision to expand or contract. Firms with a large network are more likely to continue to grow, while smaller firms are more likely to contract. Additionally, I find that geographic considerations play an important role, as shorter routes are more profitable. Additionally, airlines are much more likely to enter into a new airport when it is located closer to an existing airport in that firm's network. Though this research was carried out in the airline industry, the models, and likely the consequences, are also relevant to a number of other networked industries, particularly in transportation and telecommunications.

Identifying and understanding the extra incentives that networks introduce to firms is important because of the potential effects it can have on market-level competition and performance. My results have indicated that larger firms have increased incentive to expand, while smaller firms have increased incentive to contract. The long-run consequences of this could be significant, leading to industries consolidated among a few very large firms with smaller firms disappearing entirely. Indeed, current trends in the U.S. airline industry would support this, with a number of high profile “megamergers” in recent years, such as Delta-Northwest, United-Continental, and US Airways-American. Firms that remain operational offering increasingly large networks, while a number of smaller firms have disappeared, either to bankruptcy or acquisition. It is important to note that in the case of networked industries, there are additional incentives to merge that go beyond simply efficiency gains, or increased market power.

CHAPTER V

SUMMARY AND CONCLUSION

In the preceding chapters, I have presented an analysis of the economics of the U.S. airline industry that build upon the existing literature and make several novel contributions. In Chapter II, I investigated the demand side of the airline industry, examining consumer choice and substitution patterns between airports in multi-airport markets. Previous studies of airport choice have relied upon survey data, which are costly to acquire, and often very limited in their scope. In this chapter, I applied a technique for estimating consumer utility functions using only aggregate data. By using this technique, I was able to create estimates for consumer preferences for airports, and their substitutability. Such tables are a novelty, and could provide useful for policy makers considering the competitiveness of markets, and infrastructure expansion projects.

Chapter III takes a step back from individual agents, and looks at market performance as a whole. This chapter focused on the relationship between market structure and prices, and how they have evolved over time. The airline industry has evolved significantly over the past 20 years, driven by bankruptcies, mergers, and firms reallocating their networks. By utilizing a longer panel of data than has been used in prior studies or market structure in the airline industry, I was able to look at market evolution over time, while controlling for unobserved heterogeneity across firms, markets, and time. I find that the effects of entry, exit, and mergers vary widely across markets. Firms operate complex networks, and a decision to merge, for example, can effect hundreds of different markets—each one differently, depending on the prior market presence of each firm. This can make broad analysis more complicated, particularly for policymakers who are trying to evaluate the effects of a potential merger. As there are so many markets, each with different effects, my work illustrates how it is important to examine the full spectrum rather than trying to focus on a singular conclusion.

As Chapter III illustrated, the effects of firm decisions across networks can vary widely, making analysis complicated not only for economists, but for the firms themselves. In Chapter IV, I look at decision-making by firms operating over a network, and how their network structure affects their decisions. Specifically, I focus on entry and exit decisions of firms into and out of airports. Prior work on entry and exit in the airline industry has focused on entry and exit at the route level, rather than the airport level. I look at the role of airports in the networks, and examine the firms' incentives to enter and exit using a discrete choice model. I find that firms with larger networks have increased incentives to expand, while firms with smaller networks have increased incentives to contract. Additionally, geography plays an important role in the cost of expansion, as firms tend to expand the geographic breadth of their network gradually.

Collectively, this body of work has presented several advancements to the fields of industrial organization and transportation economics. I have analyzed the airline industry from several different perspectives: consumer decisions, firm decisions, and market performance. I have also used a variety of techniques, both structural and non-structural depending on the problem. The contributions of this work would be relevant not only to economists, but also to policymakers considering issues surrounding air travel, and some of the techniques I have developed could be applied in the study of other networked industries as well.

APPENDIX

ADDITIONAL TABLES

Table 16: New York City Elasticities

	Full Model				Local Model			
New York								
	EWR	JFK	LGA	Market	EWR	JFK	LGA	Market
AA	-0.021	-0.238	-0.403	-0.203	-0.005	-0.229	-0.363	-0.182
AS	-0.012	-0.024	0.003	-0.011	-0.031	-0.026	0.007	-0.018
B6	0.024	-0.437	0.033	-0.109	0.025	-0.439	0.052	-0.104
CO	-0.969	0.238	0.066	-0.292	-0.871	0.233	0.071	-0.253
DL	-0.130	-0.787	-0.401	-0.408	-0.081	-0.749	-0.318	-0.352
F9	0.010	0.012	-0.044	-0.006	0.014	0.016	-0.055	-0.007
FL	0.020	0.025	-0.094	-0.014	0.012	0.013	-0.056	-0.009
NK	0.005	0.004	-0.020	-0.003	0.004	0.003	-0.014	-0.002
NW	-0.020	-0.021	-0.088	-0.041	-0.017	-0.018	-0.086	-0.039
UA	-0.208	-0.059	-0.201	-0.162	-0.169	-0.053	-0.203	-0.145
US	-0.292	-0.127	-0.287	-0.242	-0.246	-0.073	-0.243	-0.194
VX	0.010	-0.076	0.005	-0.017	0.012	-0.085	0.006	-0.019
WN	0.017	0.021	-0.074	-0.010	0.015	0.018	-0.065	-0.009
YX	0.011	0.005	-0.039	-0.006	0.006	0.006	-0.025	-0.003

Table 17: Washington, DC Elasticities

Washington, DC	Full Model				Local Model			
	BWI	DCA	IAD	Market	BWI	DCA	IAD	Market
AA	-0.075	-0.230	-0.059	-0.117	-0.023	-0.072	-0.024	-0.038
AS	0.004	-0.018	0.002	-0.003	0.002	-0.007	0.000	-0.001
B6	0.007	0.013	-0.067	-0.010	0.002	0.006	-0.031	-0.005
CO	-0.084	-0.096	-0.003	-0.067	-0.035	-0.031	0.000	-0.025
DL	-0.195	-0.296	-0.113	-0.205	-0.081	-0.103	-0.036	-0.076
F9	0.010	-0.044	0.011	-0.006	0.003	-0.014	0.004	-0.002
FL	-0.122	-0.034	-0.006	-0.067	-0.037	-0.014	-0.006	-0.022
NK	0.001	-0.004	0.001	0.000	0.000	-0.001	0.000	0.000
NW	-0.035	-0.040	-0.001	-0.028	-0.016	-0.019	-0.001	-0.013
UA	-0.088	0.047	-0.749	-0.211	-0.017	0.016	-0.272	-0.070
US	-0.198	-0.439	0.036	-0.211	-0.057	-0.138	0.017	-0.063
VX	0.008	0.006	-0.042	-0.005	0.001	0.001	-0.007	-0.001
WN	-0.308	0.081	-0.046	-0.127	-0.108	0.030	-0.021	-0.045
YX	0.007	-0.034	0.007	-0.005	0.003	-0.014	0.003	-0.002

Table 18: Chicago Elasticities

Chicago	Full Model			Local Model		
	MDW	ORD	Market	MDW	ORD	Market
AA	0.282	-0.445	-0.221	0.219	-0.293	-0.135
AS	0.013	-0.016	-0.007	0.006	-0.007	-0.003
B6	0.004	-0.008	-0.004	0.002	-0.003	-0.001
CO	0.031	-0.052	-0.026	0.019	-0.031	-0.016
DL	-0.310	-0.090	-0.158	-0.280	-0.066	-0.132
F9	-0.172	0.013	-0.044	-0.098	0.007	-0.026
FL	-0.224	0.016	-0.058	-0.142	0.009	-0.037
NK	0.003	-0.003	-0.001	0.002	-0.001	0.000
NW	-0.051	-0.009	-0.022	-0.068	-0.008	-0.027
U5	0.001	-0.001	0.000	0.001	-0.001	0.000
UA	0.413	-0.644	-0.318	0.317	-0.429	-0.199
US	0.108	-0.147	-0.068	0.089	-0.120	-0.056
WN	-1.350	0.099	-0.348	-1.021	0.067	-0.269

Table 19: Dallas Elasticities

Dallas	Full Model			Local Model		
	DAL	DFW	Market	DAL	DFW	Market
AA	0.478	-0.532	-0.323	0.256	-0.370	-0.240
AS	0.009	-0.018	-0.012	0.001	-0.004	-0.003
CO	-0.149	-0.041	-0.063	-0.046	-0.032	-0.035
DL	-0.018	-0.137	-0.112	-0.030	-0.085	-0.074
F9	0.034	-0.043	-0.027	0.011	-0.017	-0.011
FL	0.023	-0.026	-0.016	0.021	-0.023	-0.014
NW	-0.030	-0.008	-0.013	-0.023	-0.007	-0.010
SY	0.000	0.000	0.000	0.000	0.000	0.000
UA	0.025	-0.086	-0.063	0.026	-0.067	-0.048
US	0.146	-0.191	-0.121	0.071	-0.102	-0.066
WN	-1.569	0.048	-0.288	-0.880	0.049	-0.144
YX	0.004	-0.010	-0.007	0.003	-0.006	-0.004

Table 20: San Francisco Elasticities

San Francisco	Full Model				Local Model			
	OAK	SFO	SJC	Market	OAK	SFO	SJC	Market
AA	0.112	-0.133	-0.320	-0.107	0.112	-0.090	-0.290	-0.078
AS	-0.053	-0.016	-0.037	-0.030	-0.022	-0.013	-0.006	-0.014
B6	-0.085	-0.005	-0.001	-0.025	-0.086	0.000	0.000	-0.022
CO	0.051	-0.080	-0.121	-0.054	0.040	-0.063	-0.062	-0.036
DL	-0.110	-0.205	-0.111	-0.161	-0.112	-0.105	-0.070	-0.100
F9	0.025	-0.021	-0.048	-0.014	0.019	-0.013	-0.039	-0.010
FL	0.007	-0.014	0.006	-0.004	0.005	-0.009	0.004	-0.002
G4	-0.003	0.000	0.000	-0.001	-0.004	0.000	0.000	-0.001
NW	0.011	-0.031	-0.020	-0.018	-0.001	-0.016	-0.010	-0.011
UA	0.024	-0.465	-0.025	-0.246	-0.038	-0.258	-0.011	-0.149
US	-0.269	-0.096	-0.107	-0.144	-0.269	-0.054	-0.057	-0.111
VX	0.019	-0.044	0.021	-0.014	0.011	-0.018	0.010	-0.004
WN	-0.795	0.004	-0.294	-0.267	-0.358	-0.001	-0.155	-0.126
YX	0.002	-0.002	0.001	-0.001	0.002	-0.002	0.001	0.000

Table 21: Los Angeles Elasticities

Los Angeles	Full Model				Local Model			
	BUR	LAX	LGB	Market	BUR	LAX	LGB	Market
AA	-0.127	-0.166	0.108	-0.138	-0.360	-0.241	0.248	-0.220
AS	-0.068	-0.040	-0.179	-0.056	-0.026	-0.043	-0.033	-0.039
B6	-0.021	0.007	-0.842	-0.066	-0.027	0.013	-1.227	-0.094
CO	0.031	-0.059	0.031	-0.037	0.046	-0.085	0.043	-0.054
DL	-0.012	-0.210	-0.489	-0.201	0.059	-0.257	-0.299	-0.210
F9	0.014	-0.011	0.015	-0.005	0.027	-0.027	0.031	-0.014
FL	0.012	-0.021	0.012	-0.013	0.023	-0.034	0.026	-0.020
G4	0.000	-0.001	0.000	0.000	0.002	-0.007	0.000	-0.005
NK	0.000	-0.001	0.001	0.000	0.001	-0.002	0.003	-0.001
NW	0.010	-0.017	0.012	-0.010	0.029	-0.043	0.012	-0.027
RJ	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SY	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
UA	-0.180	-0.241	0.271	-0.189	-0.034	-0.303	0.211	-0.218
US	-0.217	-0.104	-0.335	-0.141	-0.414	-0.109	-0.571	-0.196
VX	0.030	-0.020	0.030	-0.008	0.016	-0.026	0.047	-0.013
WN	-0.472	-0.057	0.158	-0.107	-0.626	-0.091	0.171	-0.156
YX	0.006	-0.004	0.007	-0.002	0.009	-0.009	0.006	-0.005

Table 22: Carrier Codes

Carrier Code	Carrier Name
AA	American Airlines Inc.
AS	Alaska Airlines Inc.
B6	JetBlue Airways
CO	Continental Air Lines Inc.
DL	Delta Air Lines Inc.
F9	Frontier Airlines Inc.
FL	AirTran Airways Corporation
G4	Allegiant Air
NK	Spirit Air Lines
NW	Northwest Airlines Inc.
RJ	Alia-(The) Royal Jordanian
SY	Sun Country Airlines d/b/a MN Airlines
SY	Sun Country Airlines
U5	USA 3000 Airlines
UA	United Air Lines Inc.
US	US Airways Inc.
VX	Virgin America
WN	Southwest Airlines Co.
YX	Midwest Express Airlines

REFERENCES CITED

Airlines for American (A4A). "U.S. Airline Mergers and Acquisitions." N.p., n.d. Web. 12 Jan. 2014. <http://www.airlines.org/Pages/U.S.-Airline-Mergers-and-Acquisitions.aspx>.

Bailey, Elizabeth E, and John C Panzar. "The Contestability of Airline Markets During the Transition to Deregulation." *Law and Contemporary Problems* (1981): 125-45. Print.

Barwick, Panle Jia, and Steven Berry. "Tracing the Woes: An Empirical Analysis of the Airline Industry." (2010). Print.

Basar, Gzen Bhat Chandra. "A Parameterized Consideration Set Model for Airport Choice: An Application to the San Francisco Bay Area." *Transportation Research: Part B* 38.10 (2004). Print.

Berry, Steven, Michael Carnall, and Pablo T Spiller. "Airline Hubs: Costs, Markups and the Implications of Customer Heterogeneity." *Competition policy and antitrust* (2006). Print.

Berry, Steven, James Levinsohn, and Ariel Pakes. "Automobile Prices in Market Equilibrium." *Econometrica: Journal of the Econometric Society* (1995): 841-90. Print.

Berry, Steven T. "Estimation of a Model of Entry in the Airline Industry." *Econometrica: Journal of the Econometric Society* (1992): 889-917. Print.

Borenstein, Severin. "Airline Mergers, Airport Dominance, and Market Power." *The American Economic Review* 80.2 (1990). Print.

---. "Hubs and High Fares: Dominance and Market Power in the Us Airline Industry." (1989). Print.

Brueckner, Jan K. "Airline Traffic and Urban Economic Development." *Urban Studies* 40.8 (2003): 1455-69. Print.

---. "Airport Congestion When Carriers Have Market Power." *American Economic Review* (2002): 1357-75. Print.

Brueckner, Jan K, Darin N Lee, and Ethan S Singer. "Alliances, Codesharing, Antitrust Immunity, and International Airfares: Do Previous Patterns Persist?" *Journal of Competition Law and Economics* 7.3 (2011): 573-602. Print.

Brueckner, Jan K, Darin Lee, and Ethan Singer. "City-Pairs Versus Airport-Pairs: A Market-Definition Methodology for the Airline Industry." *Review of Industrial Organization* 44.1 (2014): 1-25. Print.

Brueckner, Jan K, and W Tom Whalen. "The Price Effects of International Airline Alliances*." *The Journal of Law and Economics* 43.2 (2000): 503-46. Print.

Ciliberto, Federico, and Elie Tamer. "Market Structure and Multiple Equilibria in Airline Markets." *Econometrica* 77.6 (2009): 1791-828. Print.

Ciliberto, Federico, and Jonathan W Williams. "Limited Access to Airport Facilities and Market Power in the Airline Industry." *Journal of Law and Economics* 53.3 (2010): 467-95. Print.

Dresner, Martin, Robert Windle, and Yuliang Yao. "Airport Barriers to Entry in the Us." *Journal of Transport Economics and Policy* (2002): 389-405. Print.

Dubé, Jean-Pierre, Jeremy T Fox, and Che-Lin Su. "Improving the Numerical Performance of Static and Dynamic Aggregate Discrete Choice Random Coefficients Demand Estimation." *Econometrica* 80.5 (2012): 2231-67. Print.

Evans, William N, and Ioannis N Kessides. "Localized Market Power in the Us Airline Industry." *The Review of Economics and Statistics* (1993): 66-75. Print.

Forsyth, Peter. "Airport Competition: Regulatory Issues and Policy Implications." (2006). Print.

Graham, David R, Daniel P Kaplan, and David S Sibley. "Efficiency and Competition in the Airline Industry." *The Bell Journal of Economics* (1983): 118-38. Print.

Hsu, C. Wu Y. "The Market Size of a City-Pair Route at an Airport." *Annals of Regional Science* 31.4 (1997): 391-410. Print.

International Air Transport Association (IATA). *Annual Report 2011*. 2011.

Kim, E. Han Singal Vijay. "Mergers and Market Power: Evidence from the Airline Industry." *American Economic Review* 83.3 (1993). Print.

Kwoka, John, and Evgenia Shumilkina. "The Price Effect of Eliminating Potential Competition: Evidence from an Airline Merger*." *The journal of industrial economics* 58.4 (2010): 767-93. Print.

McFadden, Daniel, and Kenneth Train. "Mixed Mnl Models for Discrete Response." *Journal of applied Econometrics* 15.5 (2000): 447-70. Print.

Morrison, Steven A. "Actual, Adjacent, and Potential Competition: Estimating the Full Effect of Southwest Airlines." *Journal of transport Economics and Policy* (2001): 239-56. Print.

Morrison, Steven A, and Clifford Winston. "Empirical Implications and Tests of the Contestability Hypothesis." *JL \& Econ.* 30 (1987): 53. Print.

---. "The Dynamics of Airline Pricing and Competition." *American Economic Review* 80.2 (1990): 389-93. Print.

Oum, Tae H, and Xiaowen Fu. *Impacts of Airports on Airline Competition: Focus on Airport Performance and Airport-Airline Vertical Relations*: OECD/ITF Joint Transport Research Centre Discussion Paper, 2008. Print.

Pels, Eric, Peter Nijkamp, and Piet Rietveld. "Airport and Airline Choice in a Multiple Airport Region: An Empirical Analysis for the San Francisco Bay Area." *Regional Studies* 35.1 (2001): 1-9. Print.

---. "Airport and Airline Competition for Passengers Departing from a Large Metropolitan Area." *Journal of Urban Economics* 48.1 (2000): 29-45. Print.

Pels, Eric, and Erik T Verhoef. "The Economics of Airport Congestion Pricing." *Journal of Urban Economics* 55.2 (2004): 257-77. Print.

Peters, Craig. "Evaluating the Performance of Merger Simulation: Evidence from the Us Airline Industry*." *Journal of Law and Economics* 49.2 (2006): 627-49. Print.

Reiss, Peter C, and Pablo T Spiller. "Competition and Entry in Small Airline Markets." *JL \& Econ. S179* 32 (1989). Print.

Revelt, David, and Kenneth Train. "Mixed Logit with Repeated Choices: Households' Choices of Appliance Efficiency Level." *Review of economics and statistics* 80.4 (1998): 647-57. Print.

Train, Kenneth. *Discrete Choice Methods with Simulation*. Cambridge university press, 2009. Print.

United States Department of Transportation Federal Aviation Administration (FAA). *The Economic Impact of Civil Aviation on the U.S. Economy*. 2011.

Wei, Wenbin Hansen Mark. "Impact of Aircraft Size and Seat Availability on Airlines Demand and Market Share in Duopoly Markets." *Transportation Research: Part E* 41.4 (2005). Print.

Whalen, W. "A Panel Data Analysis of Code-Sharing, Antitrust Immunity, and Open Skies Treaties in International Aviation Markets." *Review of Industrial Organization* 30.1 (2007): 39-61. Print.

Windle, Robert Dresner Martin. "Airport Choice in Multiple-Airport Regions." *Journal of transportation engineering /* 121.4 (1995): 332. Print.