ESTIMATING FARE AND EXPENDITURE ELASTICITIES OF DEMAND FOR AIR TRAVEL IN THE U.S. DOMESTIC MARKET

A Dissertation

by

AHMAD ABDELRAHMAN FAHED ALWAKED

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2005

Major Subject: Economics

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Approved by:

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	Steve Puller
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ABSTRACT

Estimating Fare and Expenditure Elasticities of Demand for Air Travel in the U.S. Domestic Market. (December 2005)

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This study estimates the demand for domestic air travel services in the United States in order to calculate the fare and expenditure elasticities of demand. We segmented the market according to number of operating airlines, distances and traveler types. Using Seemingly Unrelated Regression to estimate the Almost Ideal Demand System (AIDS), we find that the expenditure and uncompensated own-fare elasticities are around unity and consistent with the previous literature. Results reveal a tendency of uncompensated own-fare elasticity to decrease as distance increases, and a tendency of uncompensated own-fare elasticity to increase as number of airlines increases. Due to few observations, business travelers' results are not reliable to make any conclusion. Leisure travelers' results are closer to all travelers' results.

DEDICATION

To my late parents, Mariam & Abdel-Rahman AlWaked

for their boundless passionate, support and keenness;

and all my family members, for their firm support and sincere love.

This dissertation and the degree will not be without

their definite encouragement and devotion.

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TABLE OF CONTENTS

Page

ABSTRACT ………………………………………………………………………….. iii

DEDICATION …………………………………………………………………….. iv

ACKNOWLEDGEMENTS ………………………………………………………. v

TABLE OF CONTENTS …………………………………………………………. vii

LIST OF TABLES ……………………………………………………………….. ix

CHAPTER

I INTRODUCTION ………………………………………………………. 1

II THE LITERATURE OF DEMAND FOR AIR TRAVEL ELASTICITIES 7

Elasticity and Its Determinants …………………………….. 7
Measurement Issues …..…………………………………… 15
Previous Studies Results ...………………………………… 18

III THE MODEL …………………………………………………………….. 25

Air-Travelers' Decision Tree ………………………………. 25
The Model ………………………………………………….. 27

IV DATA AND ESTIMATION RESULTS…..……………………………… 36

Data ………………….…………………………………… 36
Descriptive Statistics ….…………………………………… 39
Estimation Results ………………………………………… 47
Leisure and Business Travelers' Estimation Results………... 73

V CONCLUSIONS ……………………………………………….…… 107

REFERENCES ……………………………………………………………….. 111

APPENDIX A ………………………………………………………………… 115

APPENDIX B ………………………………………………………………… 136

Page

APPENDIX C 157

APPENDIX D 159

APPENDIX E 161

APPENDIX F 162

APPENDIX G 163

APPENDIX H 164

VITA 165

LIST OF TABLES

TABLE Page

1 Descriptive Statistics for Markets with Two Airlines ……………………….. 41

2 Descriptive Statistics for Markets with Three Airlines ………………………. 42

3 Descriptive Statistics for Markets with Four Airlines ………………………... 44

4 Descriptive Statistics for Markets Five-and-More Airlines ………………….. 45

5 Estimation Results of the All Distances: Markets with Two Airlines ……….. 51

6 Estimation Results of the All Distances: Markets with Three Airlines ……… 53

7 Estimation Results of the All Distances: Markets with Four Airlines ……….. 58

8 Estimation Results of the All Distances: Markets with Five-and-More Airlines 62

9 Compensated and Uncompensated Own-Fare and Expenditure Elasticities: Markets with Two Airlines …………………………………………………… 66

10 Compensated and Uncompensated Own-Fare and Expenditure Elasticities: Markets with Three Airlines…………………………………………………… 67

11 Compensated and Uncompensated Own-Fare and Expenditure Elasticities: Markets with Four Airlines …………………………………………………… 69

12 Compensated and Uncompensated Own-Fare and Expenditure Elasticities: Markets with Five-and-More Airlines …………………………………….. 71

13 Descriptive Statistics for Leisure Travelers: Markets with Two Airlines …… 75

14 Descriptive Statistics for Business Travelers: Markets with Two Airlines ….. 76

15 Descriptive Statistics for Leisure Travelers: Markets with Three Airlines ….. 78

16 Descriptive Statistics for Business Travelers: Markets with Three Airlines … 79

17 Descriptive Statistics for Leisure Travelers: Markets with Four Airlines …… 81

18 Descriptive Statistics for Leisure Travelers: Markets with Five-and-More Airlines ……………………………………………………………………… 82

19 Estimation Results of Leisure Travelers: Markets with Two Airlines ………. 85

20 Estimation Results of Business Travelers: Markets with Two Airlines ……… 87

TABLE Page

21 Estimation Results of Leisure Travelers: Markets with Three Airlines…….. 88

22 Estimation Results of Business Travelers: Markets with Three Airlines…..... 91

23 Estimation Results of Leisure Travelers: Markets with Four Airlines……… 93

24 Estimation Results of Leisure Travelers: Markets with Five-and-More Airlines ………………………………………………………………... 96

25 Compensated & Uncompensated Own-Fare and Expenditure Elasticities for Leisure Travelers: Markets with Two Airlines…………………………….. 100

26 Compensated & Uncompensated Own-Fare and Expenditure Elasticities for Business Travelers: Markets with Two Airlines...………………………… 101

27 Compensated & Uncompensated Own-Fare and Expenditure Elasticities for Leisure Travelers: Markets with Three Airlines…....................................... 102

28 Compensated & Uncompensated Own-Fare and Expenditure Elasticities for Business Travelers: Markets with Three Airlines...………………………... 102

29 Compensated & Uncompensated Own-Fare and Expenditure Elasticities for Leisure Travelers: Markets with Four Airlines…………………………….. 103

30 Compensated & Uncompensated Own-Fare and Expenditure Elasticities for Leisure Travelers: Markets with Five-and-More Airlines………………….. 105

CHAPTER I

INTRODUCTION

This dissertation estimates the demand for domestic air travel services in the United States (U.S.) in order to calculate the fare and expenditure elasticities of demand. Travel demand studies have estimated the demand and fare elasticity by using varied approaches, but none of these studies used the Almost Ideal Demand System approach (hereafter, AIDS) in the estimation.

The focus of this dissertation is to estimate the demand for air travel services facing airlines in different market structures. Also, this dissertation examines the factors that produce the differences in airfare responsiveness. The estimation of demand in airline industry, and calculation of fare elasticity is a very important exercise to examine the effect of airlines mergers, to enhance the airlines pricing strategy, or to quantify the welfare gain or loss of travelers. The precision of the estimated demand coefficients will help in testing the responsiveness of air travelers to changes in airfares more accurately, and consequently, to help establish the actions of airlines or public policy makers.

The analysis in this dissertation encompasses major national and regional airlines (see Appendix F for a complete list). These airlines serve most of U.S. domestic airports and compete with each other in different airports combinations.

This dissertation follows the style and formats of *The Journal of Law, Economics & Organization.*

Since deregulation in 1978, the airlines have the freedom to set airfares and routes served. During the pre-deregulation period 1938-78**,** the Civil Aeronautics Board (CAB) controlled both the routes airlines flew and the airfares they charged, with the goal of serving the public interest. Jung & Fujii (1976) reported an incident that happened between CAB and airlines regarding the difference in estimated fare elasticity of demand for air travel between San Francisco and Los Angeles. This study indicated the importance of estimating fare elasticity of air travel demand more precisely, and how different estimation models produced different fare elasticities. The CAB and airlines estimated the fare elasticity of air travel demand, and tried to support their decisions or requests of fare changes. CAB estimated that the demand for air travel was elastic, which means a reduction in fare will increase the airlines' total revenue. Airlines estimated the demand for air travel was inelastic, which means a reduction in fare would decrease the airlines' total revenue.

Air travel demand estimation, and subsequently fare elasticity calculations, has evolved through the years. The literature on air travel demand is wide and diverse. The first estimated model was the aggregate modal split. This model was found to suffer from weak behavioral basis and a restrictive functional form. Consequently, the aggregate behavioral model of travel demand was then developed, which was based on the theory of consumer and producer behavior. The third type of model used is the disaggregated behavioral demand based on the theory of consumer behavior. The latter model has richer empirical specifications and uses all of the information provided by the data on traveler choice and modes attributes. However, the disaggregate demand model suffers from many problems such as the need to include considerable data to carry out the estimation, and the need to include information about the characteristics of all modes contains in the travelers' choice. Also, in case of large-scale studies that include large number of city pairs, disaggregate behavior demand model is less practical than the aggregate demand model.

In the last two decades, two new approaches for estimating demand have been developed and used widely. It is difficult to choose between these two approaches because each has advantages and shortcomings. The choice of any approach depends on the research question and framework. The first approach is the random coefficient discrete choice model. Although this model possesses many advantages, it needs prior parametric assumptions, and assumed functional forms. Further this model requires more computational intense than the other model. Also, if fares are extremely high, the quantity demanded still obtained. This shortcoming leads to the overestimation of the welfare effect.

The second approach is the multistage budgeting demand model. It has a flexible functional form and requires less computational work. At the same time, it requires a priori segmentation of choices and goods, which impose some restrictions on the overall pattern of substitution across the goods. This model permits an unconstrained pattern of conditional cross-fare (price) elasticities across products within a sub-segment. Also, this model aggregates perfectly over consumers without requiring a linear relationship between the quantity of a good consumed and consumer's income (or Engel curve). This model predicts that at some fare level, quantity demanded is zero. The bottom level of this model uses AIDS in the estimation.

Previous studies have predicted different behaviors by different types of travelers, business and leisure travelers; by trip distance, long, medium and short trips distances; and by destination, domestic or international. Estimated demand model should generally distinguish between these distinct market's segments, and estimate the fare elasticity separately for each segment. The estimated fare elasticity of each market segment will be more precise and reliable than the overall fare elasticity of the air travel market.

In this study, data reveal that there are nine categories of city pairs based on the number of airlines serving these city pairs. Airlines act differently based on the number of competitor(s) on the city pair. Also, the fare elasticity of demand differs with number of competitors serving those city pairs. The city pairs are segmented into five distinguished markets starting from monopoly to five airlines.

The literature on demand for air travel is broad and varied. The literature reported a wide range of value (-0.04 to –4.51) for estimated own-fare elasticity of air travel demand. Oum et al. (1992), Brons et al. (2001) and Gillen et al. (2004) attribute this wide range to many factors such as the availability of substitutes, income, motive for travel, and the time dimension of the study. Accordingly, the estimation of demand needs to distinguish between leisure or business travelers' markets, short-sun or long-run studies, and domestic or international markets.

Oum et al. (1992), Hosken et al. (2002) and Gillen et al. (2004) mention measurement drawbacks that related to the previous travel demand studies and the interpretations of the estimated elasticities. These drawbacks are the failure to include fares and attributes of substitutes, using functional forms without statistical testing, the failure to include the variables representing the time horizon of the study, and market aggregation or segmentation and the identification problem.

This dissertation estimates the fare and expenditure elasticities for domestic air travel demand in the U.S. using the second quarter data of year 2002. The dissertation differentiates between air travelers based on fare classes, and also differentiates among trip distances. This dissertation determines that the estimated conditional uncompensated own-fare elasticities are all negative, and within a range of (-0.61 to -1.29), but inelastic and around unity for most of the airlines. The conditional compensated own-fare elasticities are negative and within a range of (-0.19 to -0.97). The cross-fare elasticities are positive for the conditional compensated demand and mostly negative and small for the uncompensated demand. The explanation for the latter is that the income effect outweighs the substitution effect. The expenditure elasticity is also around unity and positive for all airlines. The largest airline always has the highest conditional uncompensated own-fare and expenditure elasticities. At the same time, it has the smallest conditional compensated own-fare elasticity. This means the largest airline can increase its fare with less effect on the number of its travelers than the other airlines in the market.

As predicted by theory, this dissertation finds that own-fare elasticities, in general, increase as we move from markets with three airlines to more airline markets, and markets with two airlines was an exception. The availability of substitutes may explain this trend in estimated own-fare. Also, estimated expenditure elasticity has two trends; expenditure elasticity increases with distance for markets with two and three airlines, and decreases with distance for markets with four and five-and-more airlines. The first trend may be explained by the quality of services provided by largest airline that results in more travelers choosing to travel with this airline for longer distances. The second trend may be explained by more competition among airlines, in particular the competition between largest airline and others. Leisure travelers show evidence of more fare elasticity than business travelers; this result is in agreement with theory predictions and empirical works.

The rest of the dissertation is organized as following: Chapter II presents the definitions of elasticity and its determinants, the available literature on travel demand models, measurements issues and estimated elasticities. Chapter III discusses the choice decision framework of air-travelers and presents the demand model. Chapter IV presents and discusses the data and estimation results. Chapter V presents the conclusions.

CHAPTER II

THE LITERATURE OF DEMAND FOR AIR TRAVEL ELASTICITIES

This dissertation estimates the fare and expenditure elasticities of demand for domestic air travel in the U.S. A key question regards the best estimation technique. The literature on the fare elasticity of domestic air travel is broad and varied. The demand models used in these studies were either models using aggregate data or discrete choice models using aggregate and micro data. This chapter discusses the definitions of elasticity and its determinants, the previous literature on travel demand models, measurements issues, and estimated elasticities.

Elasticity and Its Determinants

The fare elasticity of air travel demand measures the sensitivity of air travelers to changes in the fare of a trip, holding other factors affecting demand for air travel constant. Fare elasticity is classified into compensated and uncompensated fare elasticities. The latter is the fare elasticity derived from the ordinary or Marshallian demand, which is derived from the consumer maximization problem. The compensated fare elasticity is derived from compensated or Hicksian demand, which is derived from the consumer minimization problem (minimizes expenditure subject to a given level of utility). The compensated fare elasticity shows the substitution effect[1] of a trip fare change whereas uncompensated fare elasticity separates the income and substitution effects of a fare change. The expenditure elasticity of demand measures the sensitivity of air travelers to a change in travel expenditures, holding other factors affecting demand for air travel constant.

The fare elasticity of travel demand is affected by numerous factors. The most important factor is the availability of substitutes. Income and expenditures for travel and time are also important.

The number and closeness of substitutes to the product affect the fare elasticity of demand. For instance, the expected fare elasticity of demand for air travel will be higher for short distances because alternatives such as train, bus, ship or private owned vehicles are better substitutes for short trips. While for long distances, there are no close substitutes for air travel in terms of speed and time.

Another issue of substitutability of demand for travel is related to the level of estimated demand; if overall demand for travel is estimated, then the substitute is not to travel. Or, if the demand for each mode of transportation (called modal demand) is estimated, then the substitutes are other modes of travel. Also, if demand facing each provider of certain mode of travel (called intra-modal demand) is estimated, then the substitutes are other providers. The expected fare elasticity will be lower for overall demand and the highest for intra-modal demand because of closeness of substitutes.

[1] When the fare of an air trip by specific airline changed, there will be two effects; the first is fare change will induce traveler to choose another airline, this is the substitution effect. The other effect is a trip fare change will change traveler's real income and subsequently his choices, this is the income effect.

Travelers' expenditures are a key factor that affects the demand for travel. The consumer considers traveling by different modes of travel as intermediate good for his/her final consumption or production. Air travel is considered as luxury good. The demand for air travel will be more sensitive to a fare change when the allocated income for air travel of total traveler income is higher. For air travel, Mutti & Murai (1977) show that income level relates positively to the demand. Brons et al. (2001) present the relationship between travel expenditure and fare elasticity of air travel. They write

> if indeed the share of air travel demand is higher for consumers with higher income levels, this would suggest that, despite a decreasing marginal utility of income and the utility losses associated with a fare increase are higher for this group of consumers, which would imply they may be more fare sensitive than consumers with lower incomes.

The literature cites other factors that affect the substitutability of travel modes such as trip distance and the reasons for travel. Distance, in transportation economics, is considered "bad" in utility terms. As distance increases, utility decreases and the demand for travel decreases. As distance increases, substitutes for air travel become fewer, while for short distance, there are more substitutes with qualities levels more comparable to air travel. This implies a negative relationship between fare elasticity of air travel demand and distance.

The cost of the trip affects the decision travel. The cost of long distance trips will be higher than the cost of short distance trip; which implies a positive relationship between fare elasticity of air travel demand and distance. This suggests that there are two counteracting forces in the case of distance and fare sensitivity of air travel. The first is a negative relationship between distance and fare sensitivity based on the availability of substitutes, and the second is a positive relationship between both distance and fare sensitivity based on travel cost.

The reason for travel is another factor that affects the fare sensitivity of air travel. The distinction between travelers based on their reasons for travel is theoretically simple. However, it is hard to apply this distinction to empirical work unless the data contains explicit information regarding the reason for travel and other information about travelers. The empirical work uses fare classes to distinguish between business travelers and leisure travelers, which is a reasonable proxy for defining the reason for travel. The main difference between the two types of travelers is better explained by the final goal of each: a leisure traveler maximizes his utility from travel and the associated activities related to the trip, in order to enjoy the vacation given his budget constraint. Leisure expenditures are discretionary, which means travel will compete with other discretionary items in a consumer's budget. The business traveler maximizes his profit from travel and the production associated with the trip such as signing contracts and so on. Also, time is more important for business travelers than for leisure travelers. The fare elasticity for business travelers is expected to be lower than that of leisure travelers due to the cost of time and final product of traveling. In other words, business travelers will be willing to pay more to reduce the cost of time and to maximize their productivity during travel. The latter refers to qualities of the service provided, such as last moment booking, flexible travel plans and changes, and better conveniences.

Another issue that affects the fare elasticity of travel demand is time. In the long-run, travelers are more able to adjust for fare change. In theory, travelers are able to change the location choice and asset holdings in the long-run, but not in the short-run. Oum et al. (1992) emphasize that long-run demand studies for travel should include location factors and assets in the estimated model. The short-run fare elasticity of demand is expected to be less elastic than the long-run fare elasticity of demand. Cross-sectional studies are considered to be short-run studies and generate short-run fare elasticity of demand. Times series studies, on the other hand, generate long-run fare elasticity of demand, because data show the changes in income, competitive environment and changes in the markets.

The literature differentiates among the estimated elasticities. There are different types of estimated elasticities; the elasticity of market demand for travel which is derived from the estimation of demand for travel relative to non-travel goods. The mode-specific demand elasticities are the estimated elasticities of individual mode of transportation, and it is higher than the market demand elasticity.[2] The mode-choice elasticities are the estimated elasticities of different modes of transportation. Mostly, mode-choice studies are conducted using the discrete choice model, and the estimation is carried out for a given volume of trips or traffic among modes. Also, the mode-choice elasticity does not consider the effect of fare changes on overall passengers or trips.

[2] Taplin (1980, 1982) discussed the relationship between market demand fare elasticities (E) for travel and mode-specific fare elasticities (E_{ij}). The relationship is $E = \sum_i s_i \left(\sum_j E_{ij} \right)$ where "*s*" is the share of mode "*i*" of total trips.

In addition to the scope of estimated demand, the literature has discussed the estimation of the demand facing individual service providers. There are few studies that have tried to estimate the effect of market structure on inter-firm competition. These studies estimate the conduct parameters (also called conjectural variations) and estimate or calculate the firm specific fare elasticity of demand.

Winston (1985) surveyed the literature on transportation demand carried out in economics, engineering and management. The survey aimed to study the conceptual development in the analysis of demand and supply of transportation, and then to use this development to evaluate the efficiency of different aspects of transportation policies and strategies such as pricing, investment regulations.

Winston (1985) discusses the evolution of demand models for transportation. The survey reports three types of demand models developed over time up to 1985. The first estimated model for travel demand was the aggregate modal split model. This model aims to explain the trips' share of each mode of transportation between city pairs; hence the name of is derived from this model goal. This model attempted to determine the number of trips among modes on the basis of relative travel times and costs. The variables and data used in this model are modes' characteristics, cost of each mode, time and other variables. Also, the model may include information about passengers' characteristics such as average income and population of each of city. The model specification is ad hoc and based on the general law of demand.

Due to the weak behavioral and theoretical basis, and the restrictive functional form of the aggregate modal split model, the aggregate behavioral model of travel demand was developed. The latter model is based on consumer or producer maximization behavioral assumptions. It assumes that consumer utility maximization is presented by

$$\max\ U(X_t, X_o) \text{ subject to } P_t X_t + P_o X_o \leq Y \tag{1}$$

where X_t, X_o, P_t, P_o, Y are travel modes, other goods, cost of transportation modes, fares of other goods and disposable income, respectively. The estimated demand function is derived from indirect utility function that results from the maximization problem. The data used is aggregate data on mode shares and fare indices and other variables.

The third model type is the disaggregate behavioral demand.[3] This demand model is known also as the disaggregate discrete choice model, which has many advantages over the aggregate demand model. For example, this model is more based on the theory of consumer behavior, has richer empirical specifications and uses all the information provided by the data on traveler choice and modes attributes. This model assumes that the traveler maximizes his utility by choosing mode "j"

$$U_j = U(X_j, S; \beta) + \varepsilon_j \tag{2}$$

where X_j is a set of mode characteristics, S is a set of traveler's characteristics, β is a set of unknown parameters to be estimated, and ε_j is unobserved random utility component that influences the decision of traveler, including the idiosyncratic preferences for the "j" mode. Because part of utility is random, the model predicts choices as probabilities. Although the disaggregate demand model has advantages over other models, it suffers

[3] This term is used in transportation economics, but the common name for these models is disaggregate discrete choice models. Also, it is called individual choice models.

from many problems, such as the need to include a considerable data to carry out the estimation, and the need to include information about all modes characteristics contains in the choice set of traveler, whether it is chosen by the traveler or not. Also, in case of large scale studies that include large number of city pairs, disaggregate behavior demand model is less practical than the aggregate demand model.

In the last two decades, two new approaches for estimating demand have developed and spread. They are used to estimate the demand for differentiated products (such as air travel).[4] The pros and cons of each approach make it hard for a researcher to choose between them. The first approach is the random coefficient discrete choice model,[5] which is used by many studies such as those by Berry et al. (1996), Petrin (2002), Berry et al. (1996) and Nevo (1999). This model needs prior parametric assumptions, assumed functional forms, and imposes intensive computational work than multistage budgeting model. Also, if fares are extremely high, the quantity demanded still obtained or people still buy this product even if the fare is extremely high, i.e. approaches infinity. This shortcoming leads to the overestimation of the welfare effect. On the pros side, this model explicitly models and estimates heterogeneity, and estimates fewer parameters. The last advantage comes from modeling products as bundles of characteristics, and defining preferences over the characteristics space.

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[4] Nevo (1999) discusses these methods in some detail. Also, Hausman et al. (1994) and Chaudhuri et al. (2003) discuss and compare the discrete choice model and the multistage budgeting model. Both try to show the advantage of the used model over other models.

[5] Most of disaggregate discrete choice studies prior to this approach were not consider large scale data estimation, and not specify the random utility part of the model which include the idiosyncratic preferences toward the chosen mode and unobserved traveler and mode characteristics. The advance in computer programming and the introduction of BLP, open the way for estimation using this approach. Random coefficient approach is an extension to the discrete choice models.

The second approach is the multistage budgeting demand model. It has a flexible functional form and requires less computational work. At the same time, it requires a priori segmentation of choices and goods, which impose some restrictions on the overall pattern of substitution across the goods. This model permits an unconstrained pattern of conditional cross-fare (price) elasticities across products within a sub-segment. Also, this model aggregates perfectly over consumers without requiring linear income-consumption relationship (Engel curve). This model predicts that at some fare level, quantity demanded is zero, or in other words, at quantity equals zero the fare is not infinity. The bottom level of this model uses AIDS in the estimation.

Measurement Issues

There are different drawbacks (or pitfalls) that relate to the previous studies of demand models, and therefore, affect the interpretation of the estimated elasticities. These drawbacks were first mentioned by Oum et al. (1992), and later by Gillen et al. (2004). Also, Hosken et al. (2002) addresses some of these drawbacks that relate to horizontal merger analysis. The following are the most common drawbacks cited by the literature:

1. Fare and Service Attributes of Substitutes: modeling intermodal competition requires the inclusion of the fares and attributes of competing modes in the estimation of the demand for air travel. Air travel demand can be affected by changes in the fares and service quality of other modes, especially for short distance routes (markets). For example, if there is a contemporary increase in air travel fare, and in train travel fare

(a competing mode for air travel), the estimated model will result in underestimated own-fare elasticity, if the fare of traveling by train is not included in the estimation.

2. Functional Forms: the estimation of different functional forms of demand results in different estimated elasticities of demand even when the same data set used. Typically, studies of air travel demand use ad hoc demand specifications and have not based their choice on statistical test of alternative specification. The majority of these studies employed linear or log-linear functional specification. The linear model may yield negative cross-fare elasticity for substitutes, which are predicted to be positive. There is no guarantee a linear model will yield positive cross-fare elasticity for substitutes goods. At the same time, the log-linear model will assume constant elasticity and will not meet the adding-up requirement by microeconomic theory. In other words, the sum of expenditures shares should equal one. The discrete choice model suffers from the independence of irrelevant alternatives (hereafter, IIA) property; the exclusion of any product from the consumer choice set will result in distributing the consumers of that product to the other products according to the overall market shares of these products. The independence of irrelevant alternatives results in identical cross-fare elasticities, or in other words, restricts the substitution patterns of demand.

3. Time horizon: as discussed earlier in this chapter, the distinction between short run and long run studies is important and will imply different specifications and interpretations of the estimated models. The fare elasticity of demand becomes more

elastic in long run than in short run, because, in long run, travelers can adjust to the fare and quality changes of the air travel services.

4. Market Aggregation/Segmentation: the level of aggregation will affect the range of the elasticity estimates. Moving from aggregate markets to disaggregate markets will increase the variability in the elasticity estimates, because aggregation averages out some of the underlying variation. The context of analyses will determine the right level of aggregation. Large-scale analysis, such as estimating demand for domestic air travel demand, are better carried out using the aggregate model, because the disaggregate model is more practical and efficient in smaller samples. Another issue relating to aggregation is whether the model used in estimation is theoretically and empirically consistent with aggregation. As discussed above, air travel market segments (i.e. leisure or business trips segments) may differ significantly in its characteristics, competition and estimated elasticities. At the end of this chapter, a summary of elasticity estimates from different sources and for different countries is presented. These results will better demonstrate this point.

5. Identification Problem: data observed by researchers is data reflecting market equilibrium and the interaction of supply and demand. The purported estimation of only “demand” or “supply” will result in biased and inconsistent estimates. The identification problem is one of the most noticed problems in studies of transport demand, because most of these studies estimate demand only. This problem occurs when estimating either demand or supply by regressing the equilibrium quantity on equilibrium fares, without taking into consideration the interaction between both of

them. Subsequently the estimated relation cannot generally be identified as specifically the demand function or the supply function. Gillen et al. (2004) write

> The identification problem in air travel can be illustrated by describing the process by which fares and travel, for example, are determined in the origin-destination market simultaneously. To model this process in its entirety, we must develop a quantitative estimate of both the demand and supply functions in a system. If, in the past, the supply curve has been shifting due to changes in production and cost conditions for example, while the demand curve has remained fixed, the resultant intersection points will trace out the demand function. On the contrary, if the demand curve has shifted due to changes in personal income, while the supply curve has remained the same, the intersection points will trace out the supply curve. The most likely outcome, however, is movement of both curves yielding a pattern of fare, quantity intersection points from which it will be difficult, without further information, to distinguish the demand curve from the supply curve or estimate the parameters of either.

To sum, changes in supply conditions, holding demand conditions fixed, will result in demand estimation and vice versa. If both demand and supply conditions change simultaneously, then we cannot identify the relation we estimate unless there is additional information.

Previous Studies Results

I now turn attention to specific estimation results from the literature. I focus on the literature after the deregulation of the aviation sector on 1978.

Oum et al. (1990, 1992) surveyed more than seventy studies published in academic journals, books and reports. The latter study focused only on studies published in academic journals that reported the own-fare elasticity of air travel for two types of estimates; mode-specific and mode-choice elasticities. Oum's first study examines market demand elasticities of air travel, the mode-choice elasticities and some cross-fare elasticities.

Own-fare demand elasticity for air passenger travel estimates range between -0.4 to -4.51 for all of the thirty one studies that conducted between years 1978-89, while most estimates fall in the range of -0.8 to -2.0. For studies that differentiate between types of travelers, own-fare elasticity for business travelers was -0.65 for times series, -1.15 for cross section studies and -0.90 for others. Own-fare elasticity for leisure travelers was within the range of -0.40 to -1.98 for times series, -1.52 for cross section studies and -1.40 to –4.60 for others. For studies that do not differentiate between types of travelers, the range was -0.36 to -1.81 for times series, -0.76 to –4.51 for cross section studies and -0.53 to -1.90 for others. These results are consistent with theoretical predictions except for cross-section and time series estimates. For disaggregate discrete choice models, estimated own-fare elasticities were lower than for the aggregate demand model estimates with a range of -0.18 to -0.62.

Oum et al. (1990) also reports the estimates of mode-choice own-fare elasticity and cross-fare elasticities of few studies. Estimates of mode-choice own-fare elasticity, with respect to vacation and non-vacation air travelers, are -0.38 and -0.18, respectively. The range of own-fare elasticity was -0.26 to -5.26 for the studies that did not distinguish among the purposes of air travel. The reported estimates of the cross-fare elasticity were in the range of -0.01 to -0.12 for bus-air and air-bus modes and in range of 0.01 to 0.51

for rail-air and air-rail modes. The cross-fare elasticities estimates indicate that bus and air traveling are complements and rail and air travel are substitutes.

Brons et al. (2001) surveyed thirty seven studies for the purpose of testing whether the estimated fare elasticities are statistically equal, and if not, explaining the variation in these elasticities. The average of own-fare elasticity, for the surveyed studies, is -1.146 with standard deviation of 0.619, and with a range of 0.21 to -3.20. Business travelers were found to be less fare sensitive than leisure travelers, and their own-fare elasticity is less than one. Using the estimates of fare elasticity from the surveyed studies, Brons et al. (2001) conducted a meta-regression and showed that business travelers are less fare sensitive, and air travelers are becoming more fare sensitive with time (more fare elastic in the long run).

Gillen et al. (2004) surveyed twenty one studies in developed countries including the U.S. The goal was to report all or almost all of the empirically estimated demand for air travel, to collect a range of fare elasticities measures and to provide some judgment regarding the elasticities value that are more representative of the true value. They developed a meta-analysis that provides measures of dispersion while, at the same time, recognizes the quality of demand estimates based on a number of the selected study's characteristics.

Gillen et al. (2004) report that the range of the own-fare elasticity for all surveyed studies is between 0.04 to -3.2 with a median of -1.122. For studies that distinguished between trips distances, long distance (1500 miles or more) own-fare elasticity median is -0.857 and a range of -0.010 to -2.234, and medium and short distance own-fare elasticity median is -1.15 with a range of 0.04 to -3.2. For studies that distinguish between time horizons, cross section own-fare elasticity median is -1.33 with a range of -0.181 to -2.01, and time series own-fare elasticity median is -0.847 with a range of 0.04 to -2.54. These estimates are in agreement with the theory predictions except for time series, which is predicted to be more than cross-section studies. The short distances own-fare elasticity is more elastic than long distance elasticity, and the own-fare elasticity of overall distances is in between.

The survey shows that studies distinguish between air travelers' types reveal that business travelers are less fare sensitive than leisure travelers. The distribution of the studies' results of own-fare elasticities is highly skewed with high variances, which explains the authors' focus on the median. They also showed that for recent studies, conducted for the two periods (1997-02) and (1992-1997), the median own-fare elasticity of demand tends to be higher for recent years than before (-0.847 and -0.56, respectively). The latter interpretation should be taken with caution since the date of study completion does not mean that the data used are more recent. It is noteworthy to mention here that Brons et al. (2001) and Gillen et al. (2004) reach the same conclusion that own-fare elasticity of demand tends to be more elastic with time.

Bhadra (2003) estimate the demand for air travel using local area economics and demographic activities. The study examines the relationship between air travel and local area characteristics. The empirical model used in this study is semi-log linear demand relationship, categorizing the model as aggregate demand models. The data used is for the years 1999-2000. The study combines demographical data and airline data; part of the airline data extracted from DB1A but not all DB1A data. He defines the distance between the city pair as the non-stop trip distance. He specifies all distance groups starting from 250 miles with an addition of 250 up to the 2500 miles distance, and then adds 500 after that.

Bhadra's study found that the elasticity for short distance (0-1249 miles) is less elastic than for other distances groups. Also, medium (1250-1999 miles) and long distance (2000-3000 miles) have similar elasticities, and the range was -0.557 to -1.815. These results contradicted with theory predictions and with previous empirical studies' results. Income elasticity is the highest for short distance; about 3.0 for distance (0-250) miles, and it is mostly statistically significant for both origin and destination.[6] Other results of this study are the positive effects of income and demographic characteristics on travel. The increase of economic activities leads at some point to decrease in travel. Also, large hubs, existence of Southwest airline and higher share of established airlines are important for travelers.

There are only a few studies that estimate demand for air travel facing air service providers. Brander and Zhang (1990, 1993) studies examined the inter-firm competition within duopoly market and used estimated elasticities from other study. The range of these elasticities was -1.2 to -2.0 as taken from Oum, Gillan and Noble (1986) and from Mutti and Murai (1977). Brander and Zhang's main conclusion was that the Cournot model is more consistent of the data than the Bertrand or Cartel models.

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[6] The paper does not show any table of estimation for income coefficients. The results indicated are from the text of the paper.

Oum, Zhang and Zhang (1993) estimate the market demand and the demand facing air service providers in the context of monopoly and duopoly city pairs served by American and United airlines. The average own-fare elasticity for market demand is -1.58 with a range of -1.24 to -2.34. Own-fare elasticities of demand facing airlines were estimated to be similar for duopoly markets, and range between -1.85 to infinity. Also, doupolists own-fare elasticity increases with distance. The main findings of this paper are that airliners' pricing methods are not identical and each airliner uses different pricing strategies for different route based on the competitive conditions on a given route. Also, the doupolists' behavior is between Cournot and Bertrand model, and much closer to Cournot behavior.

To summarize, the literature reports a wide range of estimated own-fare elasticities. Many factors may cause this wide range of elasticity estimates: failure to consider some specification problems, neglecting intermodal competition, data used, variables definitions, sample period and the variety of models used in estimation and their shortcomings.

The literature reveals different behavior by different types of travelers (business and leisure travelers), by trip distance (short, medium and long trips) and by destination whether domestic or international trips. The estimated demand model should distinguish between these distinct market's segments, and estimate the fare elasticity separately for each segment. The estimated fare elasticity of each market segment will be more precise and reliable than the overall fare elasticity of the air travel market. Also, the model used should be built on solid theoretical basis, and yield consistent model estimation when using aggregate data or household data.

This dissertation addresses the issues of market segmentations, data aggregation and the drawbacks of previous studies. More specifically, the dissertation uses a flexible demand system that overcomes some of the pitfalls of previous studies, at the same time, matching the travelers' choice decisions. The model used generates different types of fare elasticities; intramodal, mode-choice and aggregate travel demand elasticities.

CHAPTER III

THE MODEL

The model to be used in this dissertation will be a version of the AIDS demand system. Air travel takes place in differentiated product markets. Air travel is a service of moving passengers or products from one place to another by using airplanes. Each airline differentiates its products by offering a package of related services to these products such as frequent flights, frequent flyer mileage and other unobserved qualities characteristics.

The AIDS model has many advantages over other demand approaches. Advantages include a flexible functional form based on microeconomic theory, computational ease, restrictions based on the theory with unconstrained cross-fare elasticity, and the model aggregates perfectly over households. Also, because air travel is a differentiated products market, there are a large number of parameters to be estimated. The problem of the large number of parameters will be avoided by using multistage approach. This chapter discusses the choice context of the air-traveler and the existing approaches to estimate the demand for air travel. This will be followed by description of the demand model specification.

Air-Travelers' Decision Tree

The AIDS model will be implemented using a multistage budgeting approach. More specifically, consider the travel decision process, which is depicted in Figure 1.

The figure shows different levels of decisions that are made by a traveler who tries to maximize his utility given his budget constraint. A traveler will decide whether to travel or not to maximize his utility given his budget constraint. For example, given that the traveler has sufficient income, he may consider traveling or staying home. This traveler may use his income to travel or to buy a new car, or for home maintenance. At the same time, if the traveler is a businessman or is working for a firm, the decision to travel for a business meeting or to have a video or a tele-conference will be considered upon the profit generated by that decision.

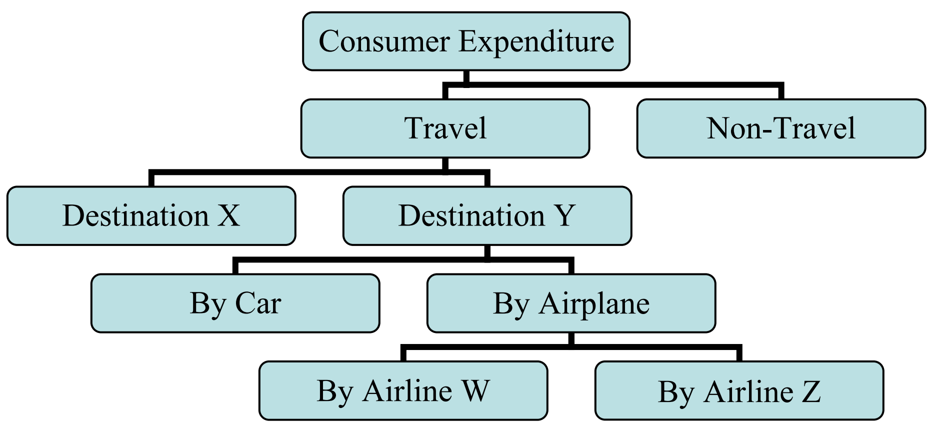

Figure 1. The Consumer Decision Tree Regarding Travel[7]

If the traveler decides to travel, the traveler must decide where to go and the mode of transportation to use (vehicle, train, bus or airplane). In this stage, traveler is maximizing his utility given his travel budget constraint. This stage will be determined by the budget for travel and accommodation if he can afford to go for longer time or to a

[7] This figure is taken from Brons et al. (2001) with some modification.

far away place instead of a near place, or to use his own vehicle or cheaper transportation means to reach his chosen destination. For business trips, it will be based on the cost of trip and the time spent on traveling; the cost of time will be involved in the decision. Also, this stage may be thought of as traveler choosing to go to a destination that yields the maximum utility given his budget constraint. The change in fare will induce the traveler to choose another destination that will maximize his utility given his budget constraint. The alternative destination characteristics are important in the travel decision. In this argument, the decision is merely a leisure traveler decision, and not a business traveler decision.[8]

Once the traveler selects the mode of transportation and destination, the next decision is the airline choice. The leisure traveler will decide upon the fare of the trip offered by the different airlines serving that route, while the business traveler will focus on quality including time, frequency of trips and other air travel qualities.

The Model

The multistage budgeting demand model has been used by Hausman (1996), Ellison et al. (1997) and Hausman et al. (1994). The model has a flexible functional form and computationally less demanding. At the same time, it requires prior segmentation of goods that imposes restrictions on the overall pattern of substitution across the goods. The substitution patterns implied by the lower level demand specification (mostly used the AIDS demand system) permits an unconstrained pattern of conditional cross-fare

[8] See Brons et al. (2001), pp3.

elasticities across products within a sub-segment. Given that competition among differentiated products tends to be highest within sub-segments, this lack of restrictions at the lower stage is a considerable advantage of AIDS over alternative approaches. An additional advantage is that the AIDS model, though developed with micro data in mind, aggregates perfectly over consumers without requiring linear Engel curves. Finally, the implied demand curves intersect the fare axis, so that the virtual fare is not infinity.

Given traveler decision tree, multistage budgeting is the proper model for the estimation of the demand for the air travel. Nevo (1999) writes:

> Multistage budgeting occurs when the consumer can allocate total expenditure in stages; at the highest stage expenditure is allocated to broad groups, while at lower stages group expenditure is allocated to sub-groups, until expenditures are allocated to individual products. At each stage the allocation decision is a function of only that group total expenditure and fares of commodities in that group (or fare indexes for the sub-groupings). All these allocations must equal those that would occur if the maximization was done in one complete information step.

This describes the model well. This model has many great characteristics such as reducing the number of parameters estimated by segmenting the products into groups, easy to estimate, and it is matching the decision process of the rational traveler. At the same time, I can test the specification of the segments of the model.

I used a multistage demand model developed by Gorman (1971). Following Hausman (1994), Hausman, Leonard and Zona (1994), Ellison et al. (1997) and Chaudhuri et al. (2003), I modeled my empirical demand in a three-stage demand system. I followed closely Hausman (1994) and Hausman, Leonard and Zona (1994).

The top-level demand will correspond to the overall demand for travel. The middle level will correspond to the demand for each mode of transportation (i.e. own vehicles, bus, train, vessel and air). And the bottom level will produce the demand for different airlines services.

Multistage budgeting demand estimation begins with the bottom level stage, which permits consistent estimation for higher demand levels. The typical empirical works, that apply multistage budgeting demand estimation, have used AIDS for the bottom level of demand. Deaton and Muellbuer (1980) sum up the pros of AIDS as

> Our model,…, gives an arbitrary first-order approximation to any demand system; it satisfies the axioms of choice exactly; it aggregates perfectly over consumers without invoking parallel linear Engel curves; it has a functional form which is consistent with known household-budget data; it is simple to estimate, largely avoiding the need for non-linear estimation; and it can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters.

The aggregation problem is the problem of whether market demand derived from macro or aggregate data is consistent with microeconomic theory under which demand estimations are based on individual consumer behavior. To overcome this problem, there are certain necessary conditions under which market demand estimation is viewed as a result of the behavior of a single utility maximizing consumer. Exact aggregation combined with a specific expenditure function leads to a demand function derived from the maximization of representative consumer. Exact aggregation assumes that consumers are different in expenditures on the product, and facing the same vector of prices.

The AIDS model is derived by specifying an expenditure function exhibits fare-independent generalized logarithmic preferences (hereafter, PIGLOG). This specification permits for exact aggregation over budget shares of different consumers. The representative consumer share function is not affected by the change in the distribution of expenditures among consumers. This share function leads to market demand based on a rational representative consumer. The PIGLOG class of preference leads to the following expenditure function:

$$\log e(u,p) = (1-u)\log\{a(p)\} + u\log\{b(p)\} \qquad (3)$$

where e (u,p) is the expenditure function, u is utility, and p is a fare vector. The functions a (p) and b(p) are positive linearly homogeneous functions, and u lies between zero (subsistence) and one (bliss). The formulas for functions a(p) and b(b) are:

$$\log a(p) = a_0 + \sum \alpha_k \log p_k + \frac{1}{2}\sum_k \sum_j \gamma^*_{kj} \log p_k \log p_j \qquad (4)$$

$$\log b(p) = \log a(p) + \beta_0 \coprod_k p_k^{\beta_k} \qquad (5)$$

The functional forms for a (p) and b (p) are chosen such that the second derivatives of the expenditure function can be set equal to those of an arbitrary expenditure function, thus satisfying the necessary condition for flexibility of functional form.

The demand function is derived from the expenditure function using Shepherd's lemma because of the fundamental property of the expenditure function that its fare derivatives are the quantity demanded. Multiplying both sides of the first derivatives of the cost function by $p_i/e(u,p)$, the left-hand side may be expressed as a budget share and the right-hand side may be expressed as a function of fares and utility. The expenditure function is then solved for u and the resulting term is substituted for u in the budget share equation. Thus, budget shares are represented by the following:

$$s_{\text{int}} = \alpha_{in} + \beta_i \log\left(\frac{E_{nt}}{P_{nt}}\right) + \sum_{j=1}^{J} \gamma_{ij} \log P_{jnt} + \varepsilon_{\text{int}} \quad (6)$$

where s_{int} is the revenue share of total air travel expenditure on the *i*th airline service in city pair "*n*" in quarter "*t*"; E_{nt} is the overall city pairs air travel expenditure; P_{jnt} is the fare of *j*th airline service in city pair "*n*"; α_{in} is the intercept or constant coefficient of the share equation "i"; γ_{ij} is the slope coefficient associated with the fare "j"; β_i is the coefficient associated with real expenditure variable and P_{nt} is a fare index. The latter is defined by

$$\log(P_{nt}) = \alpha_0 + \sum \alpha_k \log p_k + \frac{1}{2} \sum_j \sum_k \gamma_{kj} \log p_k \log p_j \quad (7)$$

The preferences specification will lead to restrictions on the parameters of the derived AIDS model to be consistent with the theory. These restrictions are divided into three sets of restrictions; Homogeneity restrictions or $\sum_{j=1}^{I} \gamma_{ij} = 0$; Symmetry restrictions or $\gamma_{ij} = \gamma_{ji}$ and the adding up restrictions or $\sum_{i=1}^{I} \beta_i = 0$, $\sum_{i=1}^{I} \alpha_i = 1$ and $\sum_{j=1}^{I} \gamma_{ij} = 0$. The first restriction implies that irrespective to the units in which fares and expenditure are expressed, the quantities purchased are not affected because the consumer's perception of opportunities is not influenced or, in other words, of absence of money illusion. This implies that fares and outlay have no influence on the consumer's choice except for determining the budget constraint. Hence, demand is homogenous of degree zero in fares and total expenditures since it is derived from a function of degree one in fares. The second restrictions satisfy the Slutsky symmetry conditions, which ensures the substitution matrix is symmetric, and the adding up restrictions reflect the constraint which the budget limitation places on the consumer, implying that budget shares sum to unity. These restrictions are satisfied automatically.

The fare aggregator (equation 7) makes the AIDS a nonlinear demand system. This nonlinearity will complicate the estimation. Deaton and Muellbauer (1980) suggest approximating this fare index by using the Stone Fare Index[9]. The Stone Fare Index is defined by $\log(P_{nt}) = \sum_{i=1}^{I} s_{in} \log(p_{\text{int}})$. They showed that the usage of the Stone Fare Index does not change the results in the case of aggregate data.[10]

The fare and expenditure elasticities can be calculated from the estimated coefficients of the model. These elasticities are partial elasticities because the multistage budgeting approach implies that goods can be partitioned into separate groups. In other words, these elasticities are calculated conditional on the expenditure on each goods group or market, and do not take the effect on the other goods of different groups.

The usage of Stone Fare Index creates the problem of which elasticity formulas to be used. Capps Jr. et al. (2003) show three alternatives for uncompensated own and cross-fare elasticity. The first alternative is to use the AIDS formula:

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[9] The usage of Stone Fare Index will linearize the AIDS and subsequently it called “Linear Approximate AIDS” or LA\AIDS (some called it LAIDS).

[10] There are many studies that showed the bias in the estimation caused by the usage of Stone fare index. The micro data studies results will be severely affected by this bias, while the aggregate data studies will not.

$$\varepsilon_{ij} = \left(\frac{\gamma_{ij}}{s_i}\right) - \delta_{ij} - \beta_i\left(\frac{s_j}{s_i}\right)\left(\alpha_j + \sum_{k=1}^{I}\gamma_{kj}\ln(p_k)\right) \tag{8}$$

where δ_{ij} is the Kronecker delta and equal one if $i = j$ and zero otherwise. All other symbols are as before. The second alternative is to use a commonly used formula:

$$\varepsilon_{ij} = \left(\frac{\gamma_{ij}}{s_i}\right) - \delta_{ij} - \beta_i\left(\frac{s_j}{s_i}\right) \tag{9}$$

The third alternative is to use the LA/AIDS fare elasticity formulas. Capps Jr. et al. (2003) provide the following formulas for own and cross-fare elasticity:

$$\varepsilon_{ii} = -1 - \frac{\beta_i}{1 + \sum_{i=1}^{I}\beta_i \ln(p_i)} + \frac{\gamma_{ii}\left(1 + \sum_{k\neq i}^{I}\beta_k \ln(p_k)\right) - \beta_i\left(\sum_{k\neq i}^{I}\gamma_{ki}\ln(p_k)\right)}{x_i\left(1 + \sum_{k\neq i}^{I}\beta_k \ln(p_k)\right) - \beta_i\left(\sum_{k\neq i}^{I}x_k \ln(p_k)\right)} \tag{10}$$

and

$$\varepsilon_{ij} = \frac{\beta_i}{1 + \sum_{i=1}^{I}\beta_i \ln(p_i)} + \frac{\left(x_i\beta_j - x_j\beta_i\right) + \gamma_{ii}\left(1 + \sum_{k\neq i}^{I}\beta_k \ln(p_k)\right) - \beta_i\left(\sum_{k\neq i}^{I}\gamma_{ki}\ln(p_k)\right)}{x_i\left(1 + \sum_{k\neq i}^{I}\beta_k \ln(p_k)\right) - \beta_i\left(\sum_{k\neq i}^{I}x_k \ln(p_k)\right)} \tag{11}$$

where $x_i = \alpha_i + \beta_i \ln(E_n) + \sum_{j=1}^{I}\gamma_{ij}\log P_j$.

Given these uncompensated fare elasticity formulas, the next decision is which one of these formulas is the most suitable. Capps Jr. et al. (2003) argue that the decision should be based on the accuracy of elasticity estimates, while Buse (1994) argues it should based on the correct demand specification. This dissertation will employ the formulas that lead to the most accurate elasticity estimates. At the same time, the employed formulas are easy to calculate.

Following Green and Alston (1990, 1991), Buse (1994), and Thompson (2004), the AIDS's income (or expenditure) elasticity formula is

$$\eta_i = 1 + \left(\frac{\beta_i}{s_i} \right) \tag{12}$$

The compensated or Hicksian cross and own-fare elasticities are

$$e_{ij} = \varepsilon_{ij} + \eta_i * s_{j_{ij}} \tag{13}$$

The symbols are the same as described above.

The middle level demand corresponds to different mode of transportation. The demand for each mode of transportation is given by the following form

$$\log q_{mnt} = \beta_n \log y_{Bnt} + \sum_{k=1}^{K} \delta_k \log \pi_{knt} + \varepsilon_{mnt} \tag{14}$$

where q_{mnt} is the quantity of the *m*th transportation mode in city pair "*n*" in quarter "*t*"; y_{Bnt} is the total expenditure on the travel in city pair "*n*" in quarter "*t*"; π_{knt} is the mode fare indices for city pair "*n*". For each transportation mode, I calculate the mode fare index from the previous estimate (bottom level estimation).

The top level stage, that will be used to estimate the demand for transportation, is specified as

$$\log u_t = \beta_0 + \beta_1 \log y_t + \beta_2 \log \pi_t + z_t \delta + \varepsilon_t \tag{15}$$

where u is the overall consumption of travel; y is the deflated disposable income; π is the deflated fare index for travel and z is a set of variables account for changes in demographics and other related factor to travel.

CHAPTER IV

DATA AND ESTIMATION RESULTS

This chapter describes the data handling, market and product definitions. Then, the chapter describes the variables extracted from the data set, and discusses the summary statistics of the relevant variables for each market. This dissertation distinguishes among different market segments; leisure and business travelers markets; short, medium and long distances markets. Accordingly, this chapter discusses the estimation results for each of these markets, and the implied fare and expenditure elasticities are discussed.

Data

The data used in this dissertation is the Origin and Destination Survey (DB1B) issued by Bureau of Transportation Statistics (hereafter, BTS) for the second quarter of year 2002. This database is a ten percent random sample of airline tickets from reporting airlines. This database has three components of which are DB1B-coupon and DB1B-ticket. The coupon component table provides coupon-specific information for each domestic itinerary of the Origin and Destination Survey, such as the operating airline, origin and destination airports, number of passengers, fare class, coupon type, trip break indicator, and distance. The ticket component table contains summary characteristics of each domestic itinerary on the Origin and Destination Survey, including the reporting airline, itinerary fare, number of passengers traveling, originating airport, roundtrip indicator, and miles flown.

I extracted the information necessary to carry out this study from the coupon and the ticket components of the DB1B. Each observation on the data file contains the information of the reporting and operating airline, origin and destination airports, number of passengers traveling, itinerary fare and miles flown.

A market is defined as a directional pair of airports (hereafter city pairs), such as Dallas (DFW)-Chicago (OHR) market is different from Chicago (OHR) - Dallas (DFW) market. A roundtrip ticket is defined as two equally fared tickets. Within each market, there are different products. I define a product as a unique combination of airline and city pair, i.e. traveling via American Airline in DFW-OHR market is a different product than traveling via United Airline in the same city pair.

One-way tickets are included in the data. These tickets are considered as products without changing their fare, while for roundtrip tickets, fares and distances are divided by two. Airlines that have less than 5 percent of total city pair expenditure or have less than one hundred passengers per quarter are excluded from data. Also, all tickets with fares below $40.0 or above $25,000 are excluded. The purpose of that is to exclude frequent flyer trip, airline employees and data entry errors. Tickets with more than four coupons are excluded. Any ticket with a foreign portion or coupon is also excluded.

Data exclusion rules are used to ensure minimal errors in the data. I included only observations where the reporting and operating airline are the same[11]. Also, I excluded airlines if the ticketing (or marketing) airline is not the same as operating airline. In other words, I kept the data for affiliated airlines when there is code sharing.

In this dissertation, there are twenty one airlines, eleven of which are major airlines and the rest are national and regional airlines.[12] The inclusion of only these airlines will enable reliable estimation of demand for air travel. The excluded airlines are sufficiently different such that they would add a noise to the estimation.

The data are classified according to the number of airlines serving each city pair. The data reveal that there are nine categories of city pairs based on the number of airlines serving those city pairs. Airlines will act differently based on the number of competitor(s) on the city pair. As the number of airlines in a city pair increases, the competition among airlines will increases and fares decrease. Also, the fare elasticity of demand will be different as the number of airlines serving these city pairs changed.

The number of city pairs served by two or more airlines is 3,554. Markets served by one airline are excluded, because this dissertation interested in calculating own- and cross-fare elasticities. I ranked the airlines in each market based on their relative shares; one represents the airline with the largest share, two represents the second largest share

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[11] The Reporting airline is the airline that submitted data to the Office of Airline Information for a given passenger segment. The operating airline is an air airline engaged directly in the operation of aircraft in passenger air transportation. The Ticketing airline is an air airline that issued a flight reservation or ticket under a code sharing agreement.

[12] See appendix F for the list of airlines.

airline, and so on.[13] Markets served by five-and-more airlines have few observations, and they are assumed to have similar demand conditions. Accordingly, for markets served by six airlines or more, the airlines ranked from one to five are kept for each of these markets, and the rest are excluded and their shares set to zero. After that, I added these observations to markets with five airlines, and redo the calculation for a new data set called markets with five-and-more airlines.

Trip distances are classified into three categories: short, medium and long trip distances. Short distance trip is a directional trip of 700 miles or less length. Medium distance trip is a directional trip of 701-1500 miles length. And the long distance trip is a directional trip of more than 1500 miles length. This dissertation followed Gillen et al. (2004) classification of distances traveled. The literature used different classifications for distance categories.

Descriptive Statistics

Each observation indicates the airline engages directly in offering air travel service for a given city pair, and submits the travelers' data to the Office of Airline Transportation. Each observation in the data set includes (i) the directional city pair that shows which airport a traveler starts the trip from (origin), and the destination airport; (ii) the total number of travelers reported by each airline serving that city pair; (iii) airline revenue that is the sum of one-way paid fares of travelers flying by a specific

[13] This ranking will lead to estimate different demands for each market structure in data. The data shows the number of airlines serving city pairs range from 1-9 for the whole markets. At the same time, I am not going to estimate the demand for specific airline i.e. American Airline or Southwest.

airline between a given city pair; (iv) the average one-way paid fare for each airline serving a given city pairs, which is equal to airline revenue divided by number of passengers of that airline for a given city pair; (v) directional city pair total revenue which is the sum of airlines revenues in that city pair; (vi) airline's share which is the percentage of airline revenue of directional city pair total revenue; (vii) Stone Fare Index for that city pair, which is a fare index weighted by each airline's share for a given city pair; (viii) airline rank is a rank given to each airline based on size of its share relative to other airlines shares. For example if airline has the largest share among airlines on that city pair, then its rank is one, rank two for the second largest share airline, and so on; (ix) relative average fare that is the logarithm of average one-way paid fare of some airline divided by the smallest (share) airline average one-way paid fare; and (x) average miles flown which is the average distance flown by all passengers on that directional city pair.

Descriptive statistics for all markets are shown in Tables 1-4. As mentioned earlier, markets are divided according to the number of airlines serving the city pairs. Each table will be discussed separately. Then, overall comments on the statistics will be offered.

Table 1 shows summary statistics of markets with two airlines. There are 1827 city pairs served by two airlines. On average, the largest (share) airline acquires about 70 percent of total city pair air travel expenditure, with a standard deviation of 0.12. The standard deviation of total city pair air travel expenditure is high; the average is $86.69 thousands with a standard deviation of $164.32 thousands, and the majority of observations are below $100 thousands.

Also, Table 1 shows that the average fares for both airlines are generally monotonic in shares, or largest airline charge higher average fare than the smallest airline, and so on. For each airline, range of average fare is high and skewed to the right. The largest airline charges about 18.7 cents per mile (or its itinerary yield) on average while the smallest airline charges about 17.3 cents.

Table1. Descriptive Statistics for Markets with Two Airlines

Variable	Variable mean	Std. dev.	Range
Share of largest airline	0.70	0.12	0.50-0.94
Share of smallest airline	0.29	0.12	0.05-0.49
Average fare of largest airline ($)	209.55	82.98	62.19-689.35
Average fare of smallest airline ($)	195.40	77.77	55.03-540.37
Log (Relative average fare)	0.06	0.26	-1.02-1.25
Stone Fare Index	5.25	0.37	4.18-6.29
Total city pair expenditure ($000)	86.69	164.32	3.64-1,575.94
Log (Real city pair expenditure)	5.11	1.39	3.26-9.17
Average miles flown	1124	716	114-4902
Number of observation	1827		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

The average number of travelers for markets with two airlines is 4226 passengers for the quarter or 47 passengers per day. Also, the Stone Fare Index averages at 5.25 with a standard deviation of 0.37. Total city pair expenditure exhibits a large standard deviation, which causes the log of real city pair expenditure to exhibits the same and skews to the right. The average distance flown by travelers in these markets is 1124 miles with a standard deviation of 716 miles.

Table 2 shows summary statistics of markets with three airlines. There are 883 city pairs served by three airlines. On average, the share is 57, 27 and 16 percent for largest, second largest and smallest airlines, respectively. Some observations show that the largest airline captures more than 80 percent of total city pair expenditure. The share of largest airline has the highest standard deviation, 14 percent. The largest airline itinerary yield is about 16.4 cents per mile on average, and 15.5 and 14.5 cents for second largest and smallest airlines, respectively. Also, total city pair air travel expenditure exhibits a large standard deviation; the average is $87.95 thousands with a standard deviation of $197.48 thousands. The majority of observations are below $100 thousands.

Table 2. Descriptive Statistics for Markets with Three Airlines

Variable	Variable mean	Std. dev.	Range
Share of largest airline	0.57	0.14	0.33-0.89
Share of second Largest airline	0.27	0.09	0.05-0.45
Share of smallest airline	0.16	0.07	0.05-0.32
Average fare of largest airline ($)	228.02	88.34	74.11-728.34
Average fare of second largest airline ($)	215.94	81.22	67.24-775.03
Average fare of smallest airline ($)	202.94	74.83	69.34-545.68
Log (Relative average fare of largest airline)	0.11	0.28	-0.85-1.12
Log (Relative average fare of second largest airline)	0.06	0.28	-0.80-1.113
Stone Fare Index	5.33	0.33	4.29-6.44
Total city pair expenditure ($000)	87.95	197.48	6.76-2,931.42
Log (Real city pair expenditure)	5.21	1.14	3.52-8.70
Average miles flown	1392	715	145-5058
Number of observations	883		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

The average fares for airlines are generally monotonic in share. But for some city pairs, the average fare of the smallest airline is higher than the fare of the largest and second largest airlines. At the same time, the range of average fare for each airline is high and skewed to the right. The average number of travelers is 3992 passengers for the quarter or 44 passengers per day. Also, the Stone Fare Index averages at 5.33 with a standard deviation of 0.33. Because of the high standard deviation of total city pair expenditure, log of real city pair expenditure exhibits a high deviation and skews to the right. The average distance flown by travelers in these markets is 1392 miles with standard deviation of 715 miles.

Table 3 shows summary statistics for markets with four airlines. There are 462 city pairs served by three airlines. On average, about 47, 25, 17 and 11 percent of total city pair air travel expenditure is for the largest, the second largest, the third largest and the smallest airlines, respectively. Some observations show that the largest airline captures more than 70 percent of total city pair expenditure. Largest airline exhibits the highest standard deviation with 12 percent. There is a high deviation on total city pair air travel expenditure; the average is $57.81 thousands with a standard deviation of $85.75 thousands. The high standard deviation of total city pair air travel expenditure causes the log of city pair real expenditure to exhibits high standard deviation and skews to the right. The largest airline itinerary yield is 13.7 cents per mile on average while second largest, third larges and smallest airlines charge about 13.2, 12.9 and 12.2 cents, respectively.

Table 3 also shows that average fares for airlines are, once again, generally monotonic in shares. But, for some city pairs, the average fare of the smallest airline is higher than average fare of largest, second largest and third largest airlines. The highest standard deviation of average fare is for the smallest airline and then for the second largest airline. The average number of travelers is 2602 passengers for the quarter or 29 passengers per day. Also, the Stone Fare Index averages 5.36 with a standard deviation of 0.26. Because the total city pair expenditure exhibits a large standard deviation, log of real city pair expenditure, also, exhibits high deviation and skews to the right. The average distance flown by travelers in this market is 1671 miles with a standard deviation of 644 miles.

Table 3. Descriptive Statistics for Markets with Four Airlines

Variable	Variable mean	Std. dev.	Range
Share of largest airline	0.47	0.12	0.27-0.82
Share of second largest airline	0.25	0.06	0.06-0.42
Share of third largest airline	0.17	0.05	0.05-0.29
Share of smallest airline	0.11	0.04	0.05-0.23
Average fare of largest share airline ($)	229.92	72.03	86.89-499.55
Average fare of second largest airline ($)	222.35	73.82	90.94-619.66
Average fare of third Largest airline ($)	215.67	70.14	80.16-530.10
Average fare of Smallest airline ($)	204.68	74.56	72.15-562.54
Log (Relative average fare of largest airline)	0.12	0.27	-0.62-1.22
Log (Relative average fare of second largest airline)	0.09	0.29	-0.87-1.02
Log (Relative average fare of third largest airline)	0.06	0.28	-0.82-0.95
Stone Fare Index	5.36	0.26	4.59-6.13
Total city pair expenditure ($000)	57.81	85.75	10.80-839.87
Log (Real city pair expenditure)	5.19	0.72	3.98-8.26
Average miles flown	1671	644	509-4591
Number of observations	462		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

Table 4 shows summary statistics for markets with five-and-more airlines. There are 382 city pairs served by five-and-more airlines. On average, about 36, 23, 17, 13 and 9 percent of total city pair air travel expenditure is for the largest, the second largest, the third largest, the fourth largest and the smallest airlines, respectively. The largest airline has the highest standard deviation that equals to 9 percent. There is a high deviation on total city pair air travel expenditure; the average is $59.27 thousands with a standard deviation of $69.76 thousands.

Table (4). Descriptive Statistics for Markets with Five-and-More Airlines

Variable	Variable mean	Std. dev.	Range
Share of largest airline	0.36	0.09	0.22-0.72
Share of second largest airline	0.23	0.04	0.08-0.35
Share of third largest airline	0.17	0.03	0.06-0.26
Share of fourth largest airline	0.13	0.03	0.05-0.20
Share of smallest airline	0.09	0.02	0.05-0.16
Average fare of largest share airline ($)	231.87	76.95	108.78-787.79
Average fare of second largest airline ($)	224.75	76.55	109.94-748.04
Average fare of third Largest airline ($)	218.18	68.85	112.50-638.33
Average fare of fourth largest airline ($)	216.65	75.77	103.60-772.77
Average fare of Smallest airline ($)	208.54	78.13	101.60-841.47
Log (Relative average fare of largest airline)	0.11	0.29	-1.06-1.13
Log (Relative average fare of second largest airline)	0.07	0.30	-1.19-1.05
Log (Relative average fare of third largest airline)	0.05	0.32	-1.19-1.12
Log (Relative average fare of fourth largest airline)	0.04	0.29	-0.94-0.99
Stone Fare Index	5.36	0.23	4.87-6.40
Total city pair expenditure ($000)	59.27	69.76	13.48-1,133.35
Log (real city pair expenditure)	5.39	0.60	4.34-8.58
Average Miles flown	1888	516	587-4905
Number of observations	382		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

The average fares for airlines are generally monotonic in shares as shown in Table 4. But, for some city pairs, the average fare of the smallest airline is higher than average fare of largest, second largest, third largest and fourth largest airlines. At the same time, the range of average fare is high for all airlines and skews to the right. Standard deviation of average fare is the highest for smallest airline, and the lowest for third largest airline. The average number of travelers is 2663 passengers for the quarter or 30 passengers per day. Itinerary yield is 12.1, 11.8, 11.6 and 11.3 cents for largest, second largest, third larges, fourth largest and smallest airlines, respectively. Also, Stone Fare Index is averaged at 5.36 with standard deviation of 0.23. Because total city pair expenditure has high standard deviation, log of real city pair expenditure exhibits a high deviation and skews to the right. The average distance flown by travelers in these markets is 1888 miles with standard deviation of 516 miles.

From the above discussion of descriptive statistics, there are some remarks applied to all markets. The average miles flown are positively related to the number of airlines serving the city pair. The average fares are proportional to airline share. But some observations show that the average fare of smallest airline is higher than any of other airlines average fare in the markets. The average fare in general shows a slight increase moving from markets with two airlines up to markets with five-and-more airlines. At the same time, its standard deviation has no clear trend across all of these markets.

The largest airline dominates the markets with average share 70.5, 57.2, 47.0 and 36.7 percent for markets with two, three, four and five-and-more airlines, respectively. While the average share of the second largest airline is between 29.4-23.1 percent. The third largest and the fourth largest airlines have average shares range between 16.0-17.2

percent and 11.0-13.1 percent, respectively. However, as the number of airlines increases, the share of the largest airline decreases the most for all markets. Also, the share of the largest airline has the highest standard deviation across all airline markets.

Average city pairs total air travel expenditure exhibits a large standard deviation and skews toward the right or to higher values. This average is higher for markets with two and three airline than other airline markets.

The number of city pairs is negatively related to the number of airlines. In other words, markets with two airlines have more city pairs than markets with three airlines markets, and the latter has more city pairs than markets with four airlines and so on.

Estimation Results

The multistage budgeting approach requires specification of product segments. Accordingly, this dissertation defines product segment or group as a market served by a specific number of airlines within the domestic air travel market in the U.S. There are four different product segments: two airlines, three airlines, four airlines and five-and-more airlines. The bottom level demand in this approach is AIDS. As discussed in Chapter II, the literature revealed different estimation results for each type of travelers, and also for the different trip distances. The estimated demand model distinguishes between these distinct market's segments, and calculate the fare and expenditure elasticities separately for each segment.

The estimated system of equations overcomes the drawbacks of previous models used in estimation. This model assumes exogenous fares,[14] has a flexible functional form, is based on solid theoretical background, and is consistent with observational units and with aggregation over households.

The system of the shares equations of LA\AIDS is used in the estimation. This system is represented by the following equation:

$$s_{in} = \alpha_{in} + \beta_i \log\left(\frac{E_n}{P_n}\right) + \sum_{j=1}^{J} \gamma_{ij} \log P_{jn} + \varepsilon_{in} \quad (16)$$

where s_{int} is the revenue share of total air travel expenditure on the *i*th airline service in city pair "*n*" in quarter "*t*"; E_{nt} is the overall city pairs air travel expenditure; P_{jnt} is the fare of *j*th airline service in city pair "*n*"; α_{in} is the intercept or constant coefficient of the share equation "i"; γ_{ij} is the slope coefficient associated with the fare "j"; β_i is the coefficient associated with real expenditure variable; P_n is Stone Fare Index and ε_{in} is a random error with mean zero and constant variance.

The adding-up property of the demand system causes the error covariance matrix to be singular. The symmetry restrictions are the only restrictions imposed in the estimation, because using the smallest airline as a numeraire good satisfies homogeneity restrictions. At the same time, adding-up restrictions are satisfied by construction. The

[14] Most of literatures on AIDS and LA/AIDS did not use instrumental variables in estimation, but literature used Multistage Budgeting Demand approach used instrumental variables. A caveat should be taken in this regard; a relation may exist between fares and the error terms in each equation.

parameters of the equation dropped in the estimation are recovered by using the adding-up restrictions.

Seemingly unrelated regression (SUR) of Zellner is used to estimate the demand system presented by the share equations. This estimation method increases the efficiency of the estimated parameters if the errors in the single equations are contemporaneously correlated.

The imposition of homogeneity and/or symmetry restrictions into the model are tested by likelihood ratio test for the demand systems of each market. Also, a Chi-square test for single equation homogeneity restriction is carried out. Symmetry restrictions cannot be tested for a single equation. The results, as reported in Appendix G, show that imposing both homogeneity and symmetry restrictions are rejected for three of the four markets based on likelihood ratio test, while imposing either homogeneity or symmetry restrictions are accepted for one and two of the four markets, respectively. The single equation test of homogeneity shows that six out of ten restrictions are accepted. The results of these tests show no definite rejection of each restrictions set for all markets. The rejection of homogeneity may due to the data used in estimation; cross-section data shows relatively inflexible expenditure pattern, and the usage of aggregate data to estimate individual behavior. Also, measurement error and model misspecification (i.e. omitting dynamic effect) may cause the rejection of homogeneity restrictions. Given the restrictions tests results, the theoretical restrictions will be imposed on the estimated model; the results of these tests were not conclusive, and these restrictions are based on the theory.

Tables 5-8 show the estimated parameters of the demand systems for the four different markets for all distances or observations. The estimation results for the different distances are reported in Appendix A.

Table 5 reports the estimation results for largest and smallest airline equations in markets with two airlines for all observations. Also, estimation results for the three categories of trip distances of these markets are reported in Appendix A. Because of the adding up restriction, the estimated parameters are the same except in signs. As for the constant term, its interpretation as an intercept is not applicable to this model. It may say that as the other variables are zeros (relative fares are equal to one and the real expenditure equals $1), the share of the airline is equal to the estimated parameter. The estimated constant parameters are of values 0.55 and 0.45 for largest and smallest airlines, respectively. Also, both are significantly different from zero at the one percent level. The constant terms for short, medium and long trips distances are all significantly different from zero. But it is different for each distance; largest airline constant term is 0.67, 0.50 and 0.47 for short, medium and long trip distances, respectively.

The estimated fare parameters are the slopes of the shares equations. It shows that if the fare of the airline increases by 1 percent, the share of that airline will increase by the estimated parameter multiplied by 100. All estimated parameters are statistically significant at the one percent level, which means they are significantly different from zero, and both airlines fares have a measurable effect on the share of each. The estimated own-fare parameter of each airline shows that the increase of its fare by one percent will increase its share by 6.9 percent. The distance categories estimation results reveal no measurable effect of fares on shares of airlines for short distance estimation, since both parameters are insignificant. For medium and long distances, estimated own-fare parameters are significantly different from zero and it shows if fare increases by one percent, the share of the largest airline will increase by 9.1 and 10.3 percent for medium and long distance trips, respectively. These results indicate that the change in fares has more impact on share for longer trip distances.

Table5. Estimation Results of All Distances: Markets with Two Airlines

	Largest airline	Smallest airline
Log (Largest airline average fare)	0.069***	-0.069***
	(0.011)	(0.011)
Log (Smallest airline average fare)	-0.069***	0.069***
	(0.011)	(0.011)
Log (Real city pair expenditure)	0.028***	-0.028***
	(0.002)	(0.002)
Constant	0.558***	0.442***
	(0.011)	(0.011)
R-square	0.10	
Chi-square	208.75	
P-value	0.00	
Number of observations	1827	
Share (mean %)	70.54	29.46

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

The cross-fare parameters are mostly negative. These parameters indicate that if fares of the other airlines increase by one percent, the share of the airline will decrease by the estimated parameter multiplies by 100. Cross-fare estimated parameter shows if the fare of each airline increases by one percent, the share of the other airline decreases by 6.9 percent. For estimation results of distance categories, the cross-fare parameter estimates are statistically zero for short distance, and different from zero for medium and long trip distances.

The estimated expenditure parameters show how the share will change when the real city pair expenditure increases by one percent. Deaton and Muellbauer (1980) state that a negative sign parameter means necessities and a positive coefficient corresponds to luxuries. The estimations show that the largest airline always has a positive signed estimated parameter, and other airlines have negative signed estimated parameters. This implies that as expenditures increase, travelers are shifting to the largest airline. A one percent change in total air travel expenditure in these markets, leads to an increase in the share of largest airline by 2.8 percent and a decrease in the share of smallest airline by 2.8 percent. As for the distance categories, all estimated parameters are significantly different from zero. An increase of air travel expenditure by one percent will increase the share of largest airline by 0.8, 4.0 and 4.6 percent for short, medium and long distance trips, respectively. At the same time, the increase in air travel expenditure will decrease the share of smallest airline by 0.8, 4.0 and 4.6 percent for short, medium and long distance trips, respectively.

The R-square is 0.10. The Chi-square and associated p-value of the estimated equations show that exogenous fares and expenditure reliably explain the changes in the share.

Table 6 reports results of three estimated equations of all airlines in markets with three airlines for all observations. Also, estimation results for the three categories of trip distances of these markets are reported in Appendix A.

The estimated fares parameters are statistically significant at the one percent level, and fares have measurable effect on the share of each airline except for the fare of second largest airline.

The estimated own-fare parameter of largest airline equation, as shown in column two of Table 6, indicates that a one percent increase in largest airline fare, holding other fares and real expenditure constant, increases largest airline share by nine percent. For medium and long trip distances, the own-fare parameters are different from zero, and a one percent increase in them will increase the share of largest airline by 6.8 and 14.4 percent, respectively. The estimation for distances reveals that the fares have no effect on share of airlines at the short distance estimation. This indicates that the change in fares has more impact on share for longer trip distances.

Table 6. Estimation Results of All Distances: Markets with Three Airlines

	Largest airline	Second largest airline	Smallest airline
Log(Largest airline average fare)	0.090*** (0.019)	-0.044*** (0.013)	-0.047*** (0.009)
Log(Second largest airline average fare)	-0.044*** (0.013)	0.043*** (0.011)	0.001 (0.007)
Log(Smallest airline average fare)	-0.047*** (0.009)	0.001 (0.007)	0.045*** (0.012)
Log (Real city pair expenditure)	0.061*** (0.004)	-0.027*** (0.003)	-0.033*** (0.002)
Constant	0.249*** (0.020)	0.411*** (0.014)	0.340*** (0.010)
R-square	0.23	0.12	
Chi-square	270.47	122.32	
P-value	0.00	0.00	
Number of Observations	883	883	883
Share (mean %)	57.26	26.70	16.02

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

The cross-fare parameters in the largest airline estimated equation are negative. If fares of second largest and smallest airline increase by one percent, the share of the largest airline will decrease by 4.4 and 4.7 percent, respectively. For estimation results of medium distance, cross-fares are statistically zero for second largest airline, and significantly different than zero for smallest airline. If the fare of the smallest airline increases by one percent the share of the largest airline increases by 3.8 percent. For estimation results of long distance, cross-fares are statistically significant for second largest and smallest airlines with effect on the share of the largest airline by 8.3 and 6.1 percent, respectively. This means that the effect of smallest airline on share of largest airline is measurable.

The estimated expenditure parameters show that there is a measurable effect of expenditures on the largest airline. For all observations, a one percent increase in total real expenditure leads to 6.1 percent increase on its share. For short, medium and long distances, one percent increases in total real expenditure increase share of largest airline by 1.4, 5.8 and 7.1 percent, respectively.

R-square is 0.23 for all distances' observations, and similar across distance categories. The Chi-square and associated p-value of the estimated equation show that exogenous variables reliably explain the variations in the dependent variable, except for short distance trips where p-value is not significant.

The estimated own-fare parameter of second largest airline equation, as shown in column three of Table 6, shows that if own-fare increases by one percent, holding other fares and real expenditure constant, will be associated with increase in its share by 4.3

percent. For medium and long trip distances, the own-fare parameters are significantly different from zero. A one percent increase in own-fare will increase share of largest share airline by 4.0 and 8.4 percent, respectively. The estimation for distances reveals that the fares have no effect on share of airlines at the short distance estimation. This indicates that the change in fares has more impact on share for longer trip distances.

The cross-fare parameters in the second largest airline estimated equation are mostly negative. Cross-fare estimated parameters for all observations show if fare of the largest airline increases by one percent, holding other variables constant, the share of the second largest airline decreases by 4.4 percent. For estimation results of long distance, cross-fares are statistically significant for the largest airline, with effect on share of second largest airline by 8.3 percent. Cross-fares estimated parameters for second largest airline are statistically insignificant for short and medium distances. Effect of other airline fare airline on the share of the second largest airline is not measurable.

The estimated expenditure parameters show that there is a measurable effect of expenditure on the share of the second largest airline. For all observations, a one percent increase in total real expenditure leads to 2.7 percent decrease in its share. For short, medium and long distances, its share decreases by 0.6, 2.6 and 3.3 percent respectively.

R-square is 0.12 percent for estimation of all observations. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share, except for short distance where p-value is not significant.

The estimated own-fare parameter of smallest airline equation, as shown in column four of Table 6, shows if this fare increases by one percent, holding other fares and real expenditure constant, its share will increase by 4.5 percent. For medium and long distances, the own-fare parameters are significantly different for zero, and show increase in share of largest airline by 4.8 and 6.2 percent, respectively. The estimation for different distances reveals that the fares have no effect on airlines share of the short distance estimation.

The cross-fare parameters in the smallest airline estimated equation are mostly negative. Cross-fare estimated parameters value is 4.7 percent. For estimation results of medium and long distances, cross-fares are statistically significant for largest airline with value of 3.8 and 6.1 percent, respectively. Cross-fare estimated parameters for second largest airline are statistically insignificant. Effect of second largest airline fare on share of smallest airline is not measurable.

The estimated expenditure parameters show that there is a measurable effect of expenditure on the share of the smallest airline. For all observations, a one percent increase in total real expenditure leads to 3.3 percent decrease in share of smallest airline. For short, medium and long distances, share of smallest airline decreases by 0.8, 3.1and 3.7 percent respectively.

In summary, estimation results for markets with three airlines show that the own-fare effect of the largest airline on its share is the highest. Also, the effect of changes in real total travel expenditure is always positive on largest airline, and is negative on other airlines. While for cross-fare effect, largest airline has effect on the other airlines, and the second largest and smallest airlines have no effect on each other.

Table 7 reports the results of four estimated equations of markets with four airlines for all observations. Estimation results for trip distance categories of this market are reported in Appendix A. Eleven out of sixteen estimated parameters are statistically significant at the one and ten percent levels. The second largest airline has three insignificant fare parameters.

The estimated own-fare parameter of largest airline equation, as shown in column two of Table 7, shows that if this fare increases by one percent, holding other fares and real expenditure constant, its share will increase by 6.6 percent. For medium and long distances, the own-fare parameters are different from zero, and show an increase in its share by 8.6 and 7.2 percent, respectively. The short distance estimations of fares parameters are not significant.

The cross-fare parameters in the largest airline estimated equation are negative, and show if the fare of each of the third largest, the fourth largest and the smallest airline increases by one percent, the share of largest airline will decrease by 1.4, 3.0 and 2.1 percent, respectively. For estimation results of trips' distances, four out of nine estimated cross-fare parameters are statistically different from zero. Estimated parameters show that the third largest share airline fare has clear effect on the share of largest airline for the different trip distances.

The estimated expenditure parameters show that there is a measurable effect of expenditure on the largest airline. For all observations, a one percent increase in total real expenditure leads to 10 percent increase on its share, and 16.3, 10.2 and 9.3 percent for short, medium and long distances, respectively.

The R-square is 0.34 for all observations. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the variations in the share.

Table 7. Estimation Results of All Distances: Markets with Four Airlines

	Largest airline	Second largest airline	Third largest airline	Smallest airline
Log(Largest airline average fare)	0.066***	-0.014	-0.030***	-0.021***
	(0.022)	(0.013)	(0.010)	(0.007)
Log(Second largest airline average fare)	-0.014	0.017	0.008	-0.010*
	(0.013)	(0.012)	(0.007)	(0.006)
Log(Third largest airline average fare)	-0.030***	0.008	0.021***	0.002
	(0.010)	(0.007)	(0.007)	(0.005)
Log(Smallest airline average fare)	-0.021***	-0.010*	0.002	0.029***
	(0.007)	(0.006)	(0.005)	(0.010)
Log (Real city pair expenditure)	0.100***	-0.033***	-0.036***	-0.031***
	(0.006)	(0.004)	(0.003)	(0.002)
Constant	-0.055*	0.421***	0.359***	0.275***
	(0.033)	(0.021)	(0.016)	(0.011)
R-square	0.36	0.15	0.25	
Chi-square	269.8	81.7	156.46	
P-value	0.00	0.00	0.00	
Number of observations	463	463	463	463
Share (mean %)	46.85	25.02	17.06	11.08

Standard errors are in parentheses

*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

The estimated fare parameters of second largest airline equation, as shown in column three of Table 7, are statistically insignificant except for one parameter. Estimated parameters show no effect of fares on the share of the second largest airline.

The estimated expenditure parameters show that there is a measurable effect of expenditure on the share of the second largest airline. For all observations, a one percent increase in total real expenditure leads to 3.3 percent decrease on its share. For short, medium and long distances, its share decreases by 7.1, 3.7 and 2.8 percent, respectively.

The R-square is within a range of 0.13-0.58 for all estimated equation of second largest airline in markets with four airlines. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the variations in the share.

The estimated fare parameters of third largest airline equation, as shown in column four of Table 7, are statistically significant for six out of sixteen parameters (includes estimated parameters of different distances). One percent increase in own-fare leads to increase on the share of the third largest airline by 2.1 and 3.1 percent for all observations and medium distance trips, respectively. For cross-fare effect, the only measurable effect on this airline is of largest airline fare change.

The estimated expenditure parameters show that there is a measurable effect of expenditure on the share of the third largest airline. For all observations, a one percent increase in total real expenditure leads to 3.6 percent decrease in its share. For short, medium and long distances, share of third largest airline decreases by 4.5, 3.5 and 3.4 percent, respectively.

The R-square is within range of 0.25-0.41 percent for all estimated equation of the third largest airline in markets with four airlines. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the variations in the share.

The estimated fare parameters of smallest airline equation, as shown in column five of Table 7, are statistically significant for six out of sixteen parameters (includes estimated parameters of different distances). A one percent increase in own-fare leads to an increase on the share of the smallest airline by 2.9, 3.2 and 2.7 percent for all observations, medium and long distances, respectively. For cross-fare effects, there are only two significant cross-fare parameters with largest airline.

The estimated expenditure parameters show there is a measurable effect of expenditure on the share of the smallest airline. For all observations, a one percent increase in total real expenditure leads to 3.1 percent decrease in share of smallest airline. For short, medium and long distances, smallest airline’s share decreases by 4.7, 3.0 and 3.0 percent respectively.

Table 8 reports the results of the estimated shares equations of markets with five and-more airlines for all observations. Estimation results for medium and long distances of these markets are reported in Appendix A. Ten out of twenty-five estimated fare parameters (includes estimated parameters of different distances) are statistically significant at the one and ten percent levels. The second largest airline estimated fare parameters are statistically insignificant, and only one of third largest airline estimated equation is significant.

The estimated own-fare parameter of largest airline equation, as shown in column two of Table 8, shows that if this fare increases by one percent, holding other fares and real expenditures constant, its share will increase by 6.3 percent. For long distance, the own-fare parameter is different from zero. The estimation for short distance own-fare parameters is insignificant.

The cross-fare parameters in the largest airline estimated equation are mostly negative. Cross-fare estimated parameters show that if fare of fourth largest and of smallest airlines increases by one percent, the share of the largest airline decreases by 2.1 and 2.4 percent, respectively. For estimation results of distances, three out of eight estimated cross-fare parameters are statistically different from zero. The effect of smallest airline fare parameters on the share of the largest airline is measurable.

The estimated expenditure parameters show that there is measurable effect of expenditure on the share of the largest airline. For all observations, a one percent increase in total real expenditure leads to 6.5 percent increase in its share. For medium and long distances, it is 9.2 and 5.7 percent, respectively.

The R-square is between 0.16-0.30 for all observations, medium and long distances. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the variations in share.

The estimated fare parameters of second largest airline equation, as shown in column three of Table 8, are statistically insignificant except one parameter. Effect of fares on the share of the second largest airline is not measurable.

The estimated expenditure parameters show there is a measurable effect of expenditure on the share of the second largest airline. For all observations, a one percent increase in total real expenditure leads to 0.8 percent decrease in its share. For medium and long distances, her share decreases by 0.6 and 0.7 percent, respectively.

The R-square is within range of 0.01-0.05 for all estimated equation of second largest airline on markets with five-and-more airlines. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure do not reliably explain the variations in share.

Table 8. Estimation Results of All Distances: Markets with Five-and-More Airlines

	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
Log(Largest airline average fare)	0.063***	-0.006	-0.013	-0.021***	-0.024***
	(0.022)	(0.010)	(0.009)	(0.007)	(0.006)
Log(Second largest airline average fare)	-0.006	0.009	-0.001	0.0001	-0.003
	(0.010)	(0.009)	(0.005)	(0.005)	(0.004)
Log(Third largest airline average fare)	-0.013	-0.001	0.011*	0.004	-0.002
	(0.009)	(0.005)	(0.006)	(0.004)	(0.004)
Log(Fourth largest airline average fare)	-0.021***	0.0001	0.004	0.009*	0.007***
	(0.007)	(0.005)	(0.004)	(0.005)	(0.003)
Log(Smallest airline average fare)	-0.024***	-0.003	-0.002	0.007***	0.021***
	(0.006)	(0.004)	(0.004)	(0.003)	(0.009)
Log (Real city pair expenditure)	0.065***	-0.008**	-0.018***	-0.019***	-0.020***
	(0.008)	(0.004)	(0.003)	(0.003)	(0.002)
Constant	0.015	0.273***	0.270***	0.233***	0.203***
	(0.043)	(0.022)	(0.018)	(0.015)	(0.012)
R-square	15.80	1.13	8.17	11.88	
Chi-square	78.65	5.3	34.55	52.54	
P-value	0.00	0.38	0.00	0.00	
Number of observations	383	383	383	383	383
Share (mean %)	36.88	23.17	17.17	13.15	9.64

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

The estimated fare parameters of third largest airline equations, as shown in column four of Table 8, are statistically insignificant except for own-fare parameter in all observations and medium distance equations. One percent increases in own-fare leads to increase on the share of the third largest airline by 1.1 and 2.4 percent for all observations and medium distance trips. For cross-fare effect, there is no measurable effect.

The estimated expenditure parameters show there is a measurable effect of expenditure on the share of the third largest airline. For all observations, a one percent increase in total real expenditure leads to 1.8 percent decrease in her share. For medium and long distances, a one percent increase in total real expenditures lead to a decrease in its share by 2.8 and 1.6 percent, respectively.

The R-square is within a range of 0.06-0.23 for the estimated equation of second largest airline within markets with five-and-more airlines. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the variations in share.

The estimated own-fare parameters of fourth largest airline equations, as shown in column five of Table 8, are statistically significant except for medium trip distance equation. One percent increases in own-fare leads to an increase in share of fourth largest airline by 0.9 and 1.5 percent for all observations and long distance. For cross-fare effect, there are measurable effects from fares of largest and smallest airlines.

The estimated expenditure parameters show that there is a measurable effect of expenditure on the share of the fourth largest airline. For all observations, a one percent increase in total real expenditure leads to 1.9 percent decrease on her share. For medium and long distances, a one percent increase in total real expenditure will decrease her share by 3.0 and 1.6 percent, respectively.

The R-square is within range of 0.11-0.26 for all estimated equation of second largest share airline at four airlines market. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the variations in share.

The estimated own-fare parameters of smallest airline equation, as shown in column six of Table 8, are statistically significant for all observations and long distance trips. A one percent increases in own-fare leads to increase the share of smallest airline by 2.1 and 2.4 percent for all observations and long distance, respectively. For the cross-fare effect, there are measurable effects from fares of the largest and the fourth largest airlines.

The estimated expenditure parameters show that there is a measurable effect of expenditure on the share of the smallest airline. For all observations, a one percent increase in total real expenditure leads to 2.0 percent decrease in her share. For medium and long distances, a one percent increase in total real expenditure leads to decrease its share by 2.8 and 1.8 percent, respectively.

There are general comments about the estimations results. The estimations show the budget shares are more responsive to the expenditure in almost all estimation, and less responsive to the fares. Also, the estimation results of fares for short distance are mostly not different from zero.

Turning next to discuss the calculations of fare and expenditure elasticities. But before that, I discuss the decision of choosing which fare and expenditure elasticities formulas to be used in this dissertation. In Chapter III, different elasticity formulas are presented and discussed. This dissertation will employ the formulas that produce the most accurate estimates, and the ease of calculating the formulas.

The fare and expenditure elasticities are calculated at the sample average shares holding total expenditure constant. Capps Jr. et al. (2003) formulas and commonly used (equation 9) formulas are examined separately to calculate the elasticities for markets with three airlines, to investigate the difference in calculations. Capps Jr. et al. (2003) stated that their formulas are derived from semi-reduced forms used by Buse (1994). Buse (1994) finds that researchers without fear of being gone astray may use the commonly used formula. The calculated own and cross-fare elasticity using Capps Jr. et al. (2003) formulas and the differences with commonly used formulas are reported in Appendix H. Capps Jr. et al. (2003) formulas show no difference compared with commonly used formulas in this application. Nevertheless, these formulas may make a larger difference when applied in other settings.

Buse (1994) concludes that the commonly used formulas produce marginally the best estimates. Accordingly, the calculations of elasticities are based on the commonly used formulas represented by equations numbered 9, 12 and 13, in chapter III.

Tables (9-12) report fare and expenditure elasticities. Table 9 reports own-fare and expenditure elasticities for markets with two airlines. All calculated elasticities are significant at the one percent level. Uncompensated own-fare elasticity shows a decreasing trend with trip distance. Also, average uncompensated own-fare elasticity is higher than the medium and long trips own-fare elasticity. The same trend applies to the compensated own-fare elasticities. All expenditure elasticities are positive as predicted, and above one for the largest airline. The largest airline expenditure elasticity tends to increase with distance. On the other hand, the smallest airline expenditure elasticity tends to decrease with distance.

Cross-fare elasticities for all observations and all distance segments are reported in Appendix A. Uncompensated cross-fare elasticities have a negative sign. While compensated cross-fare elasticities are all positive. The reason for negative sign of uncompensated cross-fare elasticity is that income effect outweighs substitution effect.

Table 9. Compensated and Uncompensated Own-Fare and Expenditure Elasticities: Markets with Two Airlines

Airline	All distance	700 miles or less	700-1500 miles	More than 1500 miles
Uncompensated own-fare elasticity				
Largest airline	-0.930*** (0.016)	-1.000*** (0.032)	-0.911*** (0.024)	-0.896*** (0.025)
Smallest airline	-0.738*** (0.036)	-0.972*** (0.076)	-0.645*** (0.057)	-0.629*** (0.052)
Compensated own-fare elasticity				
Largest airline	-0.197*** (0.015)	-0.286*** (0.032)	-0.162*** (0.023)	-0.166*** (0.024)
Smallest airline	-0.471*** (0.036)	-0.685*** (0.076)	-0.395*** (0.057)	-0.359*** (0.052)
Expenditure elasticity				
Largest airline	1.040*** (0.007)	1.011*** (0.013)	1.057*** (0.00001)	1.068*** (0.014)
Smallest airline	0.905*** (0.00001)	0.973*** (0.00002)	0.861*** (0.005)	0.854*** (0.014)

Source: Author's calculation using Table 5 and equations 9, 12 and 13 of chapter III
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table 10 reports own-fare and expenditure elasticities for markets with three airlines. All calculated elasticities are significant at the one percent level. Uncompensated own-fare elasticity shows a decreasing trend with trip distance. The same trend applies to the compensated own-fare elasticities. Also, average uncompensated own-fare elasticity is higher than the medium and long trips own-fare elasticities.

Table 10. Compensated and Uncompensated Own-Fare and Expenditure Elasticities: Markets with Three Airlines

Airline	All distance	700 miles or less	700-1500 miles	More than 1500 miles
Uncompensated own-fare elasticity				
Largest airline	-0.902***	-1.141***	-0.942***	-0.808***
	(0.048)	(0.169)	(0.083)	(0.124)
Second largest airline	-0.813***	-1.166***	-0.821***	-0.667***
	(0.072)	(0.277)	(0.125)	(0.004)
Smallest airline	-0.684***	-1.091***	-0.654***	-0.607***
	(0.034)	(0.115)	(0.054)	(0.123)
Compensated own-fare elasticity				
Largest airline	-0.269***	-0.540***	-0.298***	-0.190***
	(0.041)	(0.142)	(0.068)	(0.100)
Second largest airline	-0.573***	-0.910***	-0.587***	-0.422***
	(0.072)	(0.277)	(0.125)	(0.00003)
Smallest airline	-0.557***	-0.948***	-0.533***	-0.471***
	(0.041)	(0.142)	(0.068)	(0.100)
Expenditure elasticity				
Largest airline	1.106***	1.024***	1.098***	1.130***
	(0.007)	(0.017)	(0.011)	(0.028)
Second largest airline	0.898***	0.977***	0.899***	0.882***
	(0.010)	(0.025)	(0.018)	(0.029)
Smallest airline	0.791***	0.944***	0.796***	0.780***
	(0.072)	(0.277)	(0.125)	(0.00008)

Source: Author's calculation using Table 6 and equations 9, 12 and 13 of chapter III
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

All expenditure elasticities are positive, and above one for the largest airline. The largest airline expenditure elasticity tends to increase with distance. However, the second largest and the smallest airlines' expenditure elasticities tend to decrease with distance.

Cross-fare elasticities are reported in Appendix A. Uncompensated cross-fare elasticities are negative except for few estimates. Positive uncompensated cross-fare elasticity estimates suggests that second largest and smallest airlines travel services are substitutes, but those elasticities are mostly statistically insignificant. In short distance trips, estimates indicate that second largest is a gross substitute for largest share airline travel service. The compensated cross-fare elasticities are all positive, which means that a change in fare of one airline will increase the travelers of the other airline, or travelers shift to other airlines when a fare increases. Because income effect outweighs substitution effect, most of uncompensated cross-fare elasticities are negative.

Own-fare and expenditure elasticities for markets with four airlines are reported in Table 11. The table shows that all calculated elasticities are statistically significant at the one percent level except one estimate. Uncompensated and compensated own-fare elasticities are negative and more elastic for short distance trips. The third largest airline shows the highest substitution effect among all airlines.

All expenditure elasticities are positive as predicted, and they are above one for the largest airline. The largest airline expenditure elasticity tends to decrease with distance, while other airlines' expenditure elasticity tends to increase with distance. Cross-fare elasticities are reported in Appendix A.

Table 11. Compensated and Uncompensated Own-Fare and Expenditure Elasticities: Markets with Four Airlines

Airline	All distance	700 miles or less	700-1500 miles	More than 1500 miles
	Uncompensated own-fare elasticity			
Largest airline	-0.960***	-1.321***	-0.923***	-0.937***
	(0.047)	(0.137)	(0.070)	(0.066)
Second largest airline	-0.899***	-0.716***	-0.870***	-0.914***
	(0.052)	(0.197)	(0.081)	(0.070)
Third largest airline	-0.842***	-1.075***	-0.777***	-0.882***
	(0.059)	(0.307)	(0.092)	(0.080)
Smallest airline	-0.705***	-0.715	-0.664***	-0.737***
	(0.094)	(0.548)	(0.162)	(0.117)
	Compensated own-fare elasticity			
Largest airline	-0.392***	-0.647***	-0.342***	-0.386***
	(0.046)	(0.152)	(0.069)	(0.065)
Second largest airline	-0.682***	-0.565***	-0.656***	-0.691***
	(0.052)	(0.206)	(0.081)	(0.069)
Third largest airline	-0.707***	-0.960***	-0.647***	-0.742***
	(0.059)	(0.317)	(0.092)	(0.080)
Smallest airline	-0.625***	-0.654***	-0.590***	-0.651***
	(0.094)	(0.547)	(0.161)	(0.117)
	Expenditure elasticity			
Largest airline	1.213***	1.318***	1.213***	1.202***
	(0.013)	(0.058)	(0.021)	(0.017)
Second largest airline	0.868***	0.680***	0.853***	0.886***
	(0.016)	(0.091)	(0.027)	(0.020)
Third largest airline	0.787***	0.692***	0.786***	0.804***
	(0.018)	(0.137)	(0.029)	(0.022)
Smallest airline	0.721***	0.562***	0.716***	0.742***
	(0.022)	(0.163)	(0.033)	(0.026)

Source: Author's calculation using Table 7 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

Uncompensated cross-fare elasticities are mostly negative with few positives. Around half of the calculated elasticities are statistically significant including some positive signed ones. Positive cross-fare elasticity estimates for each estimated equation indicate that the travel services of those airlines are substitutes. The estimation results show no consistent sign for any cross-fare elasticity over the different distance equations for each airline, but the third largest share and smallest share airlines are substitutes. Also, the second largest share and third largest share airlines are substitutes. The compensated elasticities are all positive except for short distance estimation. Because income effect outweighs substitution effect, most of uncompensated cross-fare elasticities are negative.

Own-fare and expenditure elasticities for markets with five-and-more airlines are reported in Table 12. The table shows all calculated elasticities are statistically significant at the one and ten percent levels except few estimates. Uncompensated and compensated own-fare elasticities are negative and more elastic for medium distance trips. Compensated own-fare elasticity of fourth airline shows the highest substitution effects among all airlines.

Cross-fare elasticities are reported in Appendix A. Uncompensated cross-fare elasticities are mostly negative, and less than half are statistically significant. Positive cross-fare elasticity estimates for each estimated equation indicates that travel services for the third and fourth largest airlines are substitutes, and the same for the fourth largest and smallest airlines. Compensated elasticities are all positive.

All expenditure elasticities are positive as predicted, and above one for the largest airline. The largest and second largest airlines' expenditure elasticities tend to decrease with distance. However, other airlines' expenditure elasticities tend to increase with distance.

Table 12. Compensated and Uncompensated Own-Fare and Expenditure Elasticities: Markets with Five- and-More Airlines

Airline	All distances	700-1500 miles	More than 1500 miles
Uncompensated own-fare elasticity			
Largest airline	-0.894***	-0.934*	-0.889***
	(0.058)	(0.534)	(0.064)
Second largest airline	-0.952***	-1.022***	-0.912***
	(0.039)	(0.424)	(0.042)
Third largest airline	-0.916***	-0.821***	-0.927***
	(0.037)	(0.375)	(0.041)
Fourth largest airline	-0.910***	-0.999***	-0.873***
	(0.039)	(0.309)	(0.045)
Smallest airline	-0.765***	-0.831	-0.736***
	(0.095)	(0.728)	(0.1020
Compensated own-fare elasticity			
Largest airline	-0.461***	-0.454	-0.470***
	(0.059)	(0.535)	(0.064)
Second largest airline	-0.728***	-0.799*	-0.687***
	(0.038)	(0.424)	(0.042)
Third largest airline	-0.768***	-0.695***	-0.773***
	(0.031)	(0.320)	(0.034)
Fourth largest airline	-0.797***	-0.905***	-0.756***
	(0.037)	(0.299)	(0.042)
Smallest airline	-0.689***	-0.764	-0.658***
	(0.095)	(0.728)	(0.102)
Expenditure elasticity			
Largest airline	1.176***	1.237***	1.156***
	(0.021)	(0.159)	(0.024)
Second largest airline	0.967***	0.973***	0.969***
	(0.017)	(0.187)	(0.019)
Third largest airline	0.862***	0.776***	0.883***
	(0.018)	(0.167)	(0.021)
Fourth largest airline	0.859***	0.761***	0.883***
	(0.020)	(0.164)	(0.022)
Smallest airline	0.789***	0.704***	0.812***
	(0.023)	(0.162)	(0.023)

Source: Author's calculation using Table 8 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

Following this brief discussion of calculated elasticities for all markets, there is a summary of overall remarks and comments about these elasticities for all markets.

As discussed in Chapter II, the literature predicts own-fare elasticity of demand to increase as the number of substitutes increases. Comparison of average uncompensated own-fare elasticities of each market shows no clear trend when number of airlines increases. The exclusion of markets with two airlines from the comparison gives a general pattern of increasing uncompensated own-fare elasticity as the number of airlines increases. The largest airline's uncompensated own-fare elasticity for five-and-more airlines markets is the only exception to that trend.

The conditional uncompensated own-fare elasticity, within each market, tends to be less with trip distance for two and three airlines markets, and with no clear trend for markets with four, and five-and-more airlines. For instance, long distance trip is more fare elastic than medium distance trip for markets with four airlines. Also, the general trend of short distance uncompensated own-fare elasticity is more elastic than medium and long distances trips elasticity for all markets. The same interpretation applies to comparison of medium and long trip uncompensated own-fare elasticity for markets with two and three airlines. These results may be attributed to availability of travel substitutes other than air travel such as train. Also, these findings are supported by the literature.

The conditional uncompensated own-fare elasticity tends to be higher for the airline with higher share; the only exception is markets with five-or-more airlines. The overall conditional uncompensated own-fare elasticity is inelastic for all markets. This result implies that the decrease in fares will results in decrease in total revenue of air travel, because the percentage increase in number of air travelers will be less than the percentage decrease in fare. Also, the largest airline can increase its fare without fear of decreasing its total revenue. Combining the last two remarks, all airlines, except the largest airline, will not decrease their fares to attract more travelers.

As shown in Tables 9-12, the largest airline conditional compensated own-fare elasticity is the smallest among all airlines. Also, the smallest airline has lower conditional own-fare elasticity than the other airlines (except the largest airline). This means that the largest airline may increase its fare with less effect on its number of travelers compared with other airlines.

As discussed above, calculated elasticities show two distinct trends of expenditure elasticity for different trip distances. The first is for markets with two and three airlines, and the second is for the other two markets. For the first trend, largest airline travelers' number will increase relatively more, as distance and air travel expenditure increase. The second trend shows the reverse.

The conditional uncompensated cross-fare elasticities are mostly negative, especially for markets with two and three airlines. On the other hand, the conditional compensated cross-fare elasticities are positive, and as stated by the theory. The main reason that the uncompensated cross-fare elasticities are negative is that income effect outweighs the substitution effect.

Leisure and Business Travelers' Estimation Results:

In the previous section, all travelers' data were used for estimation without distinction between travelers' types. In this section, travelers are classified into leisure and business using fare classes. Travelers were classified based on fare classes. Business travelers are assumed to comprise restricted and non-restricted business and first class tickets excluding Southwest travelers. Leisure travelers are assumed to comprise restricted and non-restricted coach tickets and Southwest travelers. Theory predicts leisure travelers are more fare sensitive than business travelers. Oum et al. (1992), Gillen et al. (2004) and Brons et al. (2001) show empirical evidences that leisure travelers will be more fare elastic than the business travelers.

The variables are previously defined in this chapter, except that the observations are separated into two data subsets: leisure travelers' data and business travelers' data. Also, all data issues applied to the entire data set are applied here such as the definitions of products, markets, distances, and so on. Descriptive statistics for leisure and business travelers are presented in Tables 13-18.

Table 13 shows the summary statistics of leisure travelers in Markets with two airlines. There are 1815 city pairs served by two airlines. On average, the largest share airline captures about 71 percent of total city pair air travel expenditures, with a standard deviation of thirteen percent.

The average fares for both airlines are monotonic in share. At the same time, range of average fare is high for both airlines and skewed to the higher values. The itinerary yields for largest airline and for smallest airline are 17.9 and 16.8 cents, which are less than those of markets with two airlines for all travelers. For some city pairs, the average fare of the smallest airline is higher than fare of largest airline.

Total city pair air travel expenditure has a large standard deviation. The average total city pair air travel expenditure is $82.17 thousands with a standard deviation of

$151.55 thousands. The majority of observations are below $100 thousands. Also, the Stone Fare Index averages 5.11 with standard deviation of 0.35. Because the total city pair expenditure exhibits from standard deviation, log of real city pair expenditure shows high deviation and skews to the right.

Table 13. Descriptive statistics for Leisure Travelers: Markets with Two Airlines

Variable	Variable mean	Std. dev.	Range
Share of largest airline	0.71	0.13	0.50-0.95
Share of smallest airline	0.29	0.13	0.05-0.50
Average fare of largest airline ($)	206.34	76.12	65.51-580.83
Average fare of smallest airline ($)	192.32	71.72	55.64-538.05
Log (Relative average fare)	0.07	0.27	-1.10-0.99
Stone Fare Index	5.25	0.35	4.21-6.17
Total city pair expenditure ($000)	82.17	151.55	3.50-1,434.19
Log (Real city pair expenditure)	5.11	1.40	3.36-9.18
Average miles flown	1123	714	114-4903
Number of observations	1815		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

The average number of travelers is 4152 passengers for the quarter or 46 passengers per day. The average distance flown by travelers in these markets is 1123 miles with standard deviation of 714 miles.

Most of the statistics in Table 13 resembles statistics of Table 1, but most variables have lower standard deviation. Also, the fares and itinerary yields are lower in leisure travelers markets.

Summary statistics for business travelers in markets with two airlines is reported in Table 14. There are 67 city pairs served by two airlines. On average, about 68 percent of total city pair air travel expenditure is of largest airline, with a standard deviation of thirteen percent. Share of largest airline shows little difference when compared with statistics of leisure travelers and with the entire data set for two airlines markets.

The average fares for both airlines are monotonic. The fare for business travelers is higher than of leisure travelers because of the higher qualities of service they offered. The itinerary yields for the largest share airline and for the smallest share airline are 84.5 and 80.1 cents, which are much higher than of leisure travelers and entire two all observations average. For some city pairs, the average fare of the smallest share airline is higher than fare of largest share airline.

Table 14. Descriptive Statistics for Business Travelers: Markets with Two Airlines

Variable	Mean	Std. dev.	Range
Share of largest airline	0.68	0.13	0.50-0.94
Share of smallest airline	0.32	0.13	0.06-0.50
Average fare of largest airline ($)	793.93	424.45	126.81-1600.46
Average fare of smallest airline ($)	751.79	502.79	77.49-1752.71
Log (Relative average fare)	0.16	0.64	-0.85-2.63
Stone Fare Index	6.46	0.70	4.92-7.39
Total city pair expenditure ($000)	71.70	67.01	6.27-370.86
Log (Real city pair expenditure)	4.31	0.60	3.28-5.60
Average miles flown	939	535	231-2129
Number of observations	67		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

Total city pair air travel expenditure exhibits a large standard deviation. The average of this expenditure is $71.7 thousands with a standard deviation of $67. Also, the Stone Fare Index averages 6.46 with a standard deviation of 0.7. This is higher than for leisure and entire data set for markets with two airlines. The average number of travelers is 919 passengers for the quarter or 11 passengers per day that is lower than the average numbers of leisure travelers. The average distance flown by travelers on these markets is 939 miles with standard deviation of 535 miles.

In comparison with leisure travelers and all travelers (entire data set) statistics reported in Tables 1 and 13, the business travelers' statistics show distinct differences in terms of higher paid fares, lower deviation on most variables and shorter average miles flown. Also, it is worth mentioning the size of business travelers' data is relatively small. This may explain the similarity in statistics between leisure and the entire data set.

Table 15 shows summary statistics for leisure travelers in markets with three airlines. There are 881 city pairs served by three airlines. On average, about 57 percent of total city pair air travel expenditure is of largest airline, 27 percent of second largest airline and 16 percent is of smallest airline. Some observations show that the largest airline captured more than 80 percent of total city pair expenditure. The standard deviation of the largest airline is the highest with 14 percent.

The average fares for airlines are less than the entire data set average with a smaller standard deviation. Average fare of the smallest airline is higher than fare of largest and second largest airlines for several city pairs. At the same time, average fare range is lower than the entire data range, and skewed to the right. Itinerary yields for the largest, the second largest and the smallest airlines are 15.6, 14.9 and 14.1, respectively.

Total city pair air travel expenditure exhibits a large standard deviation. The average of this expenditure is $80.93 thousands with a standard deviation of $148.38 thousands. Total city pair expenditure deviates lesser than the entire markets with three airlines. The average number of travelers is 3833 passengers for the quarter or 34 passengers per day. Also, the Stone Fare Index averages 5.30 with a standard deviation of 0.31. Because the total city pair expenditure exhibits a large standard deviation, log of real city pair expenditure has high deviation and skews to the right. The average distance flown by travelers on these markets is 1397 miles with standard deviation of 718 miles.

Table 15. Descriptive Statistics for Leisure Travelers: Markets with Three Airlines

Variable	Variable mean	Std. dev.	Range
Share of largest airline	0.57	0.14	0.29-0.89
Share of second Largest airline	0.27	0.09	0.06-0.46
Share of smallest airline	0.16	0.07	0.05-0.33
Average fare of largest airline ($)	217.29	76.40	74.11-584.76
Average fare of second largest airline ($)	207.57	73.17	66.56-651.25
Average fare of smallest airline ($)	196.61	68.92	69.22-545.68
Log (Relative average fare of largest airline)	0.10	0.26	-0.66-1.08
Log (Relative average fare of second largest airline)	0.05	0.27	-0.80-1.14
Stone Fare Index	5.30	0.31	4.29-6.21
Total city pair expenditure ($000)	80.93	148.38	6.56-1,406.67
Log (Real city pair expenditure)	5.22	1.15	3.52-8.7
Average miles flown	1397	718	144-5056
Number of observations	881		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

Table 16 shows summary statistics of business travelers in markets with three airlines. There are twelve city pairs served by three airlines. On average, about 46 percent of total city pair air travel expenditure is for the largest airline, 34 percent for the second largest airline and 19 percent for the smallest airline. Standard deviation of largest airline is the highest with 9 percent. Because of fewness of observations, comparison of these statistics with leisure and entire market data is taken with caveat. There are slight differences in shares of airlines in these markets.

Table 16. Descriptive Statistics for Business Travelers: Markets with Three Airlines

Variable	Variable mean	Std. dev.	Range
Share of largest airline	0.46	0.09	0.35-0.59
Share of second Largest airline	0.34	0.05	0.22-0.41
Share of smallest airline	0.19	0.09	0.06-0.32
Average fare of largest airline ($)	1317.71	356.52	652.03-1780.79
Average fare of second largest airline ($)	1198.49	357.88	571.14-1696.27
Average fare of smallest airline ($)	986.51	186.24	759.15-1299.61
Log (Relative average fare of largest airline)	0.26	0.32	-0.20-0.80
Log (Relative average fare of second largest airline)	0.16	0.33	-0.48-0.52
Stone Fare Index	7.08	0.23	6.61-7.24
Total city pair expenditure ($000)	384.51	518.37	32.64-1,493.04
Log (Real city pair expenditure)	4.98	1.17	3.78-6.99
Average miles flown	1493	586	440-2055
Number of observations	12		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

The average fares for both airlines are monotonic in shares. The smallest airline has the smallest average fares' standard deviation, which is almost half of other two airlines standard deviation. The itinerary yields for the largest airline, the second largest and for the smallest airline are 88.3, 80.3 and 66.1 cents, respectively. These are much higher than of leisure travelers and the averages of entire data set for markets with three airlines. For some city pairs, the average fare of the smallest airline is higher than fare of largest airline.

Total city pair air travel expenditure exhibits a large standard deviation. The average of this expenditure is $384.51 thousands with a standard deviation of $518.37 thousands. Also, the Stone Price Index averages 7.08 with a standard deviation of 0.23, which is higher than for leisure and entire two airlines markets because of high business fares. The average number of travelers is 3074 passengers for the quarter or 34 passengers per day. This is lower than the average numbers of leisure travelers. The average distance flown by travelers on these markets is 1493 miles with standard deviation of 586 miles.

In comparison with leisure travelers and all travelers statistics reported in Tables 2 and 15, business travelers' statistics show distinct differences in terms of higher paid fares, lower deviation on most variables and longer average miles flown.

Summary statistics of leisure travelers in markets with four airlines are shown in Table 17. There are 458 city pairs served by three airlines. The statistics in this table resemble Table 3 statistics with few small differences in fares averages, total city pairs expenditure. Lower average fares are expected for leisure travelers by theory, and shown by the statistics.

The average number of travelers is 2555 passengers for the quarter or 28 passengers per day. Itinerary yields are 13.1, 12.7, 12.4 and 11.7 cents for largest, second largest, third larges and smallest airlines, respectively. Total city pair air travel expenditure exhibits a large standard deviation. The average of this expenditure is $54.43 thousands with a standard deviation of $76.66 thousands.

Also, the Stone Fare Index averages 5.32 with a standard deviation of 0.25. Because the total city pair expenditure suffers from high standard deviation, the log of real city pair expenditure suffers from a high deviation and skewed to the right. The average distance flown by travelers on this market is 1669 miles with standard deviation of 639 miles.

Table 17. Descriptive Statistics for Leisure Travelers: Markets with Four Airlines

Variable	Variable mean	Std. dev.	Range
Share of largest airline	0.47	0.12	0.27-0.81
Share of second largest airline	0.25	0.07	0.07-0.43
Share of third largest airline	0.17	0.05	0.05-0.30
Share of smallest airline	0.11	0.04	0.05-0.23
Average fare of largest share airline ($)	218.99	63.11	86.75-453.32
Average fare of second largest airline ($)	212.97	65.19	90.94-534.33
Average fare of third Largest airline ($)	207.69	64.54	80.16-547.07
Average fare of Smallest airline ($)	198.34	70.59	72.16-519.81
Log (Relative average fare of largest airline)	0.11	0.26	-0.66-1.02
Log (Relative average fare of second largest airline)	0.08	0.28	-0.76-0.93
Log (Relative average fare of third largest airline)	0.06	0.27	-0.82-0.81
Stone Fare Index	5.32	0.25	4.58-6.11
Total city pair expenditure ($000)	54.43	76.66	10.18-773.40
Log (Real city pair expenditure)	5.19	0.72	3.98-8.24
Average miles flown	1669	639	513-4592
Number of observations	458		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

Summary statistics of leisure travelers in markets with five-and-more airlines are shown in Table 18. There are 384 city pairs served by three airlines. The statistics in this table are similar to Table 4 statistics with a few small differences in fares averages, and total city pairs expenditure. Theoretically the lower average fares are expected for leisure travelers proved by the statistics.

The average number of travelers is 2618 passengers for the quarter or 29 passengers per day. Itinerary yields are 11.5, 11.3, 11.2, 10.9 and 10.6 cents for largest, second largest, third larges, fourth largest and smallest airlines, respectively. Total city pair air travel expenditure exhibits a large standard deviation. The average of this expenditure is $55.60 thousands with a standard deviation of $63.96 thousands. Also, the

Stone Fare Index averages 5.32 with a standard deviation of 0.21. The average distance flown by travelers on these markets is 1890 miles with standard deviation of 514 miles.

Table 18. Descriptive Statistics for Leisure Travelers: Markets with Five-and-More Airlines

Variable	Variable mean	Std. dev.	Range
Share of largest airline	0.37	0.10	0.22-0.73
Share of second largest airline	0.23	0.05	0.08-0.34
Share of third largest airline	0.17	0.04	0.07-0.26
Share of fourth largest airline	0.13	0.03	0.060.20
Share of smallest airline	0.10	0.03	0.05-0.18
Average fare of largest share airline ($)	217.90	64.84	107.00-629.79
Average fare of second largest airline ($)	213.07	61.48	109.95-609.89
Average fare of third Largest airline ($)	211.52	72.85	97.59-749.38
Average fare of fourth largest airline ($)	206.78	63.09	103.61-593.57
Average fare of Smallest airline ($)	200.56	66.51	101.61-654.53
Log (Relative average fare of largest airline)	0.09	0.28	-0.74-1.13
Log (Relative average fare of second largest airline)	0.07	0.30	-1.03-1.29
Log (Relative average fare of third largest airline)	0.05	0.31	-1.19-1.09
Log (Relative average fare of fourth largest airline)	0.03	0.29	-0.94-1.26
Stone Fare Index	5.32	0.21	4.78-6.18
Total city pair expenditure ($000)	55.60	63.96	12.93-1,046.88
Log (real city pair expenditure)	5.38	0.60	4.32-8.55
Average Miles flown	1890	514	587-4910
Number of observations	384		

Source: Author's calculation from Origin and Destination Survey (DB1B) second quarter, 2002.

From the above discussion of leisure travelers' descriptive statistics, there are a few important issues. The average miles flown are positively related to the number of airlines serving the city pair. Average fares are monotonic in share, and its standard deviation slightly decreases with more airlines serving the markets. The first two comments are similar to all travelers' statistics mentioned in the previous section.

The largest airline dominates the markets with an average share within a range of 70.3-36.7 percent. While the second airline gets average shares within a range of 29.4-23.1 percent. The third and fourth have average shares within a range of 16.0-17.2 percent and 11.0-13.1 percent, respectively. As the number of airlines increases, the share of the largest airline will decrease the most.

Average fares are closer in all markets and ranges from $192.32-217.9; these are slightly lower than of all travelers' average fares. But the itinerary yields are different and higher as the number of airlines decreases. Also, the total city pair expenditures decrease as the number of airlines increases.

To conclude the discussion of descriptive statistics for both travelers' types, there are some distinct features to mention. The differences in average fares and in their standard deviation are high between the two types. Also, Business travelers' statistics show lower standard deviation of distance traveled than leisure travelers.

The comparison of entire data set with leisure travelers' data shows differences in average fares and total city pairs expenditures. These differences in statistics are expected to produce some differences in estimation results.

Before turning to the estimation results, AIDS used to estimate, separately, the demand for each traveler's type. The estimation is carried out using SUR to estimate the shares equations (equation 16). The parameters estimated are shown on Tables 19-25.

The interpretation of the parameters is the same as discussed before. The parameters signs are as the same for Tables 5-8, but their magnitudes are slightly different except for markets with four airlines. This may due to leisure travelers' domination over business travelers in the data set. Business travelers comprise about five percent of total travelers in the entire data set.

Table 19 reports the results of two estimated equations of leisure travelers in markets with two airlines. Also, estimation results for the three categories of trip distances of these markets are reported in Appendix B. All estimated parameters fares parameters are different from zero and both airlines fares have measurable effect on the share of each.

The estimated own-fare parameter of each airline indicates that the increase of that fare by one percent, increase its share by 8.2 percent. Estimated fares parameters for short distance are insignificant for estimated equations, and it is significantly different from zero for medium and long distances. Cross-fare estimated parameter shows if fare of an airline increases by one percent, the share of the other airline decreases by 6.1 percent, and it is different than zero for medium and long trips distances.

The estimation results for the largest airline estimation results shown in column two of Table 19. The largest airline has always positive estimated parameter while the smallest airline has negative estimated parameter. A one percent change in total air travel expenditure in two airlines markets leads to an increase in the share of largest airline by 2.8 percent and a decrease in smallest airline by 2.8 percent. The interpretation is that air travelers will shift to the largest airline from other airline as air travel expenditure increases. For the different distance categories, all estimated parameters are significantly different from zero. An increase of air travel expenditure by one percent will increase the share of largest airline by 0.8, 4.0 and 5.0 percent for short, medium and long distance trips, respectively. At the same time, this increase in air travel expenditure will decrease the share of smallest airline by 0.8, 4.0 and 5.0 percent for short, medium and long distance trips, respectively.

Table 19. Estimation Results of Leisure Travelers: Markets with Two Airlines

	Largest airline	Smallest airline
Log(Largest airline average fare)	0.061***	-0.061***
	(0.011)	(0.011)
Log(Smallest airline average fare)	-0.061***	0.061***
	(0.011)	(0.011)
Log (Real city pair expenditure)	0.028***	-0.028***
	(0.002)	(0.002)
Constant	0.557***	0.443***
	(0.011)	(0.011)
R-square	0.10	
Chi-square	200.99	
P-value	0.00	
Number of Observations	1815	1815
Share (mean %)	70	30

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

The R-square is 0.1. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share.

Table 20 reports estimation results of business travelers in two airlines markets. Also, estimation results for the three distance categories of these markets are reported in Appendix B. All estimated fares' parameters are statistically significantly different from zero. The two airlines fares have measurable effect on the share of each. The estimated own-fare parameter of each airline shows that the increase of the airline fare by one increases its share by 7.9 percent. Because of the fewness of observations, there is no distance segments estimation. Cross-fare estimated parameter shows that if relative fare of each increases by one, the share of the other airline decreases by 7.9 percent.

The expenditure parameter is always positive for the largest share airline and negative for the smallest share airline. A one percent change in total air travel expenditure in these markets, leads to an increase in the share of the largest airline by 4.7 percent and a decrease in the share of the smallest airline by 4.7 percent.

The R-square is 0.15. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share.

The comparison of estimated parameters for leisure, business and entire data set shows that business travelers' parameters are higher in absolute value. This indicates that airlines' shares values are more responsive to the changes in fares and expenditure of business travelers. In other words, an increase in business fare will result in share increase of largest airline by more than the increase from leisure fare increase.

Table 21 reports the estimation results of three estimated equations leisure travelers in markets with three airlines. Also, estimation results for the trip distances of these markets are reported in Appendix B.

Most of estimated fare parameters are statistically significant at the one percent level. Airlines fares have evident effect on the share of each other, except for the fare of the second largest and the smallest airline, because their cross-fare parameters are not significant. This is similar in direction to the estimation results of entire data set for these markets.

Table 20. Estimation Results of Business Travelers: Markets with Two Airlines

	Largest airline	Smallest airline
Log(Largest airline average fare)	0.079***	-0.079***
	(0.023)	(0.023)
Log(Smallest airline average fare)	-0.079***	0.079***
	(0.023)	(0.023)
Log (real city pair expenditure)	0.047**	-0.047**
	(0.025)	(0.025)
Constant	0.468***	0.532***
	(0.109)	(0.109)
R-square	0.15	
Chi-square	12.28	
P-value	0.00	
Number of Observations	67	67
Share (mean %)	68.22	31.7

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

The estimated own-fare parameter of largest airline equation, as shown in column two of Table 21, indicates a one percent increase on own-fare, holding other fares and real expenditure constant, its share increase by 10.4 percent. For short, medium and long distances, the own-fare parameters are different from zero; a one percent increase in largest airline increases share of that airline by 13.4, 7.5 and 15.3 percent for these distances, respectively.

The cross-fare parameters in the largest airline estimated equation are negative. Cross-fare estimated parameters for all observations show that if fare of second largest or of smallest airlines increases by one percent, the share of largest airline decreases by

5.5 or 4.9 percent, respectively. For estimation results of medium trips' distance, cross-fare parameters are statistically zero for second largest, and significant for smallest airline with effect on share of largest airline by 7.5 percent. For estimation results of long distance trips, cross-fare parameters are statistically significant for the second largest and the smallest airline with effect on the share of the largest airline by 4.3 and 3.2 percent, respectively. This means that the effect of smallest airline on the share of the largest airline is measurable for all distances.

Table 21. Estimation Results of Leisure Travelers: Markets with Three Airlines

	Largest airline	Smallest airline	Smallest airline
Log(Largest airline average fare)	0.104*** (0.019)	-0.055*** (0.013)	-0.049*** (0.010)
Log(Second largest airline average fare)	-0.055*** (0.013)	0.047*** (0.011)	0.008 (0.007)
Log(Smallest airline average fare)	-0.049*** (0.010)	0.008 (0.007)	0.042*** (0.012)
Log (Real city pair expenditure)	0.061*** (0.004)	-0.027*** (0.003)	-0.034*** (0.002)
Constant	0.248*** (0.020)	0.408*** (0.014)	0.343*** (0.010)
R-square	0.24	0.12	
Chi-square	280.740	124.500	
P-value	0.00	0.00	
Number of Observations	883	883	883
Share (mean %)	26.69	16.12	16.12

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

The estimated expenditure parameters indicate a measurable effect of expenditure on the largest airline. For all observation, a one percent increase in total real expenditure leads to 6.1 percent increase on its share. For short, medium and long trips distances, it is 1.4, 5.8 and 7.1 percent respectively.

The R-square for three airlines markets is within the range of 0.19-0.30 for all observation and distances. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share.

The estimation results for the second largest airline, reported on column three of Table 21, show significant estimates for own-fare and largest airline fare for all estimates of leisure travelers data, except for short distance equation estimates. Expenditure parameters estimates are all significant with negative sign, and their effects on second largest airline are evident. For all observation, a one percent increase in total real expenditure leads to 2.7 percent decrease on her share. For short, medium and long distances, a one percent increase in total real expenditure leads to decrease its share by 0.6, 2.6 and 3.1 percent respectively.

The R-square is in the range of 0.10-0.18. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explaining the change in the share, except for short distance trips where p-value is not significant.

The estimation results for the smallest airline equations are reported on column four of Table 21. Own-fare estimated parameter shows similar results of the largest airline in terms of significant and directions for all distances and all observations, but with lower parameters value. Also, it has a measurable effect from the largest airline fare.

Table 22 reports results of the estimated equations of business travelers in the three airlines markets. Most of estimated fare parameters are statistically significant at the one percent level. Airline fares have an effect on the share of each other, except for the fare of the second largest and the smallest airline, due to their insignificant cross-fare parameters. This is similar to the estimation results of leisure travelers and entire data set for these markets.

The estimated own-fare parameter of largest airline equation shows that if this fare increases by one percent, holding other fares and real expenditure constant, its share increases by 16.8 percent. The cross-fare parameters in the largest airline estimated equation are negative. Cross-fare estimated parameters for all observations show if relative fare of the second largest and the smallest airline increases by one percent, the share of the largest airline decreases by 6.9 and 10 percent, respectively.

The estimated expenditure parameters show there is an effect of expenditures on the share of the largest airline. For all observation, a one percent increase in total real expenditure leads to 3.0 percent increase on the share of the largest airline.

The R-square for business travelers in markets with three airlines is high. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share.

The estimation results for the second largest airline, shown on column three of Table 22, indicate significant estimates for own-fare and largest airline fare for all estimates of leisure travelers data. Expenditure parameters estimates are insignificant.

The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share.

Table 22. Estimation Results of Business Travelers: Markets with Three Airlines

	Largest airline	Smallest airline	Smallest airline
Log(Largest airline average fare)	0.168*** (0.049)	-0.069** (0.032)	-0.100** (0.049)
Log(Second largest airline average fare)	-0.069** (0.032)	0.083** (0.040)	-0.014 (0.042)
Log(Smallest airline average fare)	-0.100** (0.049)	-0.014 (0.042)	0.114* (0.064)
Log (Real city pair expenditure)	0.030*** (0.013)	0.013 (0.011)	-0.044*** (0.015)
Constant	0.281*** (0.066)	0.280*** (0.056)	0.439*** (0.074)
R-square	0.64	0.33	
Chi-square	21.110	8.270	
P-value	0.00	0.04	
Number of observations	12	12	12
Share (mean %)	46.47	34.14	19.39

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

The last column of Table 22 reports the estimation results of the smallest airline equation. Estimated fare parameters are significant, except for the fare of the second largest airline. A one percent increases in own-fare parameter results in 11.4 percent increase in the share of the smallest airline. A one percent increases in largest airline fare decreases the smallest airline share by 10 percent. The share of the smallest airline will decrease by 4.4 percent if total city pairs expenditure increases by one percent.

The comparison of estimated parameters for leisure, business and entire data set shows that business travelers' parameters are higher in absolute value. Also, all estimated parameters enjoy the same characteristics with different absolute values.

Estimation results for leisure travelers in markets with four airlines are reported in Table 23. Also, estimation results for distance categories of these markets are reported in Appendix B.

The estimated own-fare parameter of largest airline equation shows if this fare increase by one percent, holding other fares and real expenditure constant, share of this airline increases by 7.0 percent. For medium and long distances, the own-fare parameters are significantly different from zero. One percent increases in own-fare of this airline increases its share by 6.2 and 10.3 percent, respectively. The estimated fare parameters in short distance equations are insignificant. The cross-fare parameters in the largest airline estimated equation are negative, and are significant for third largest and smallest airlines.

The estimated expenditure parameters show there is an evident effect of expenditure on the largest airline. For all observation, a one percent increase in total real expenditure leads to 10.1 percent increase in share of this airline. For short, medium and long trips distances, it is 16.1, 10.4 and 9.2 percent respectively. These results are similar to entire data set estimation.

The R-square of the largest airline estimated equations are within the range of 0.35-0.76. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share.

The estimated fare parameters of second largest airline equation, as shown in column three of Table 23, are statistically insignificant except one parameter. Effect of fares on the share of second largest airline is not evident.

Table 23. Estimation Results of Leisure Travelers: Markets with Four Airlines

	Largest airline	Second largest airline	Third largest airline	Smallest airline
Log(Largest airline average fare)	0.070*** (0.023)	-0.017 (0.013)	-0.032*** (0.011)	-0.021*** (0.007)
Log(Second largest airline average fare)	-0.017 (0.013)	0.012 (0.011)	0.013** (0.007)	-0.009 (0.006)
Log(Third largest airline average fare)	-0.032*** (0.011)	0.013** (0.007)	0.015** (0.008)	0.003 (0.005)
Log(Smallest airline average fare)	-0.021*** (0.007)	-0.009 (0.006)	0.003 (0.005)	0.027*** (0.010)
Log (Real city pair expenditure)	0.101*** (0.006	-0.034*** 0.004	-0.036*** (0.003)	-0.031*** (0.002)
Constant	-0.062** (0.033)	0.427*** 0.021	0.361*** (0.016)	0.274*** (0.011)
R-square	0.36	0.15	0.26	
Chi-square	156.460	87.730	159.720	
P-value	0.00	0.00	0.00	
Number of observations	458	458	458	458
Share (mean %)	46.80	24.97	17.09	11.14

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

The estimated expenditure parameters show there is a measurable effect of expenditure on the share of the second largest airline. For all observation, a one percent increase in total real expenditure leads to 3.4 percent decrease share of this airline. For short, medium and long distances, share decreases by 7.2, 3.8 and 2.9 percent respectively.

The R-square is within range of 13-54 percent for all estimated equation of the second largest airline in markets with four airlines. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share.

The estimated fare parameters of third largest airline equation are shown in column four of Table 23. Fare parameters are statistically significant for six out of sixteen parameters, which consists of all parameters estimated using the distance categories and all observations of leisure travelers. One percent increases in own-fare leads to an increase in share of third largest airline by 1.5 and 2.2 percent for all observations and long distance trips. For cross-fare effect, the only airline effect that may be measurable is of the largest airline.

The estimated expenditure parameters show there is an effect of expenditures on third largest airline. For all observation, a one percent increase in total real expenditure leads to a 3.6 percent decrease in this airline share. For short, medium and long trips distances, its share decreases by 4.8, 3.6 and 3.4 percent, respectively.

The R-square is within the range of 0.24-0.53 for all estimated equation of second largest share airline at markets with four airlines. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in share.

The estimated fare parameters of smallest airline equation are reported in column five of Table 23. Five out of the sixteen fare estimated parameters are statistically significant. One percent increases in own-fare leads to increase share of third largest airline by 2.7 and 3.3 percent for all observations and medium distance, respectively. For cross-fare effect, there is no measurable effect across different distances, except two significant cross-fare parameters with largest airline.

The estimated expenditure parameters show there is a measurable effect of expenditure on the share of the smallest airline. For all observation, a one percent increase in total real expenditure leads to 3.1 percent decrease in its share. For short, medium and long trips distances, its share decreases by 4.1, 3.0 and 3.0 percent respectively. These are close to entire data set estimation results.

Table 24 reports results of estimated equations of markets with five-and-more airlines for leisure travelers. Also, estimation results for medium and long distance trips of this market are reported in Appendix B.

The estimated fares parameters are the slopes of the share equations. Twelve out of twenty-five estimated parameters are statistically significant at one and ten percent. The second largest airline estimated fare parameters are statistically insignificant.

The estimated own-fare parameter of largest airline equation shows that if this fare increases by one percent, holding other fares and real expenditure constant, its share will increase by 7.8 percent. For medium and long distances, the own-fare parameters are significant, and a one percent increases in this fare leads to an increase in its share by 11.2 and 6.8 percent, respectively.

The cross-fare parameters in the largest airline estimated equation are mostly negative. Cross-fare estimated parameters for all observations show if fare of third largest, of fourth largest and of smallest airlines increases by one percent, the share of the largest airline decreases by 1.8, 2.6 and 2.8 percent, respectively. For estimation results of distance categories, three out of eight estimated cross-fare parameters are statistically different from zero.

The estimated expenditure parameters show there is an effect of expenditure on the largest airline. For all observation, a one percent increase in total real expenditure leads to 6.8 percent increase on its share. For medium and long distances, the increase in its share will be 10.1 and 5.7 percent, respectively.

Table 24. Estimation Results of Leisure Travelers: Markets with Five-and-More Airlines

	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
Log(Largest airline average fare)	0.078***	-0.006	-0.018**	-0.026***	-0.028***
	(0.022)	(0.010)	(0.009)	(0.007)	(0.006)
Log(Second largest airline average fare)	-0.006	0.003	0.0003	0.004	-0.001
	(0.010)	(0.009)	(0.005)	(0.005)	(0.005)
Log(Third largest airline average fare)	-0.018**	0.0003	0.018***	0.0001	0.0001
	(0.009)	(0.005)	(0.006)	(0.004)	(0.004)
Log(Fourth largest airline average fare)	-0.026***	0.004	0.0001	0.014***	0.008**
	(0.007)	(0.005)	(0.004)	(0.005)	(0.004)
Log(Smallest airline average fare)	-0.028***	-0.001	0.0001	0.008**	0.021***
	(0.006)	(0.005)	(0.004)	(0.004)	(0.009)
Log (real city pair expenditure)	0.068***	-0.010***	-0.018***	-0.019***	-0.021***
	(0.008)	(0.004)	(0.003)	(0.003)	(0.002)
Constant	-0.002	0.288***	0.267***	0.233***	0.203*
	(0.042)	(0.021)	(0.017)	(0.014)	(0.012)
R-square	18.34	1.84	8.97	12.96	
Chi-square	94.050	8.010	37.840	61.410	
P-value	0.00	0.15	0.00	0.00	
Number of Observations	384	384	384	384	384
Share (mean %)	36.70	23.18	17.25	13.13	9.74

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

The R-square of estimated equations ranges between 0.15-0.35 for all observation, medium and long distances. The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share.

The estimated fare parameters of second largest airline equation are reported on column three of Table 24. These parameters are statistically insignificant except for two parameters. Effect of cross-fares on share of second largest airline is not evident.

The estimated expenditure parameters show there is a measurable effect of expenditure on the share of the second largest airline. For all observation, a one percent increase in total real expenditure leads to one percent decrease in its share. For medium and long distances, one percent increases in real travel expenditure decreases its share by 1.1 and 0.9 percent, respectively.

The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure do not reliably explain the change in the share except medium distance equation.

Third largest airline estimated fare parameters are reported in column four of Table 24, and they are statistically significant except for own-fare parameter for all observations and medium distance equations. A one percent increases in own-fare leads to an increase in the share of the third largest airline by 1.8 and 3.2 percent for all observations and medium distance.

All expenditure parameters are statistically significant. For all observation, a one percent increase in total real expenditure leads to 1.8 percent decrease on its share. For medium and long trips distances, its share decreases by 2.9 and 1.3 percent, respectively.

The Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in share.

The estimated own-fare parameters of fourth largest airline equations are statistically significant except for medium trip distance equation. As shown on Table 24, a one percent increases in own-fare increases the share of fourth largest airline by 1.4 and 2.2 percent for all observations and long distance.

The estimated expenditure parameters are significant. A one percent increase in total real expenditure leads to 1.9 percent decrease in the share of the fourth largest airline. For medium and long distance trips, the share of the fourth largest airline decreases by 3.1 and 1.5 percent, respectively. Chi-square and associated p-value of the estimated equation show that exogenous fares and expenditure reliably explain the change in the share.

The estimated own-fare parameters of smallest airline equation are statistically significant for all observations and long distance trips. One percent increases in own-fare increases its share by 2.1 and 2.2 percent for all observations and long distance, respectively.

The estimated expenditure parameters are statistically significant. A one percent increase in total real expenditure leads to 2.1 percent decrease in its share. For medium and long trips distances, its share decreases by 3.0 and 1.9 percent, respectively.

Next a turn to calculation of fare and expenditure elasticities, holding total air travel expenditure constant, at sample average shares. The calculations of the elasticities are based on the formulas represented by equations numbered 9, 12 and 13, which are discussed in Chapter III.

Tables 25-30 report fare and expenditure elasticities for leisure and business travelers separately. Each table will be discussed separately and then compare to relevant tables. The comparison includes all travelers' elasticities.

Own-fare and expenditure elasticities for leisure travelers in markets with two airlines are reported in Table 25. All calculated elasticities are different from zero or statistically significant at the one percent level. Uncompensated own-fare elasticity shows an increasing trend with trip distance. Also, average uncompensated own-fare elasticity is higher than the medium and short trips own-fare elasticity. The same trend applies to the compensated own-fare elasticities.

All expenditure elasticities are positive, and above one for the largest share airline. The largest airline expenditure elasticity slightly increases with distance. At the same time, the smallest airline expenditure elasticity tends to decrease with distance. Same result was shown in all observations results.

Cross-fare elasticities are reported in Appendix B. Uncompensated cross-fare elasticities are mostly negative except for one, and are statistically significant. Compensated cross-fare elasticities are all positive and statistically different from zero.

Table 25. Compensated & Uncompensated Own-Fare and Expenditure Elasticities for Leisure Travelers: Markets with Two Airlines

Airline	All distance	700 miles or less	700-1500 miles	More than 1500 miles
	Uncompensated own-fare elasticity			
Largest airline	-0.942*** (0.016)	-1.009*** (0.031)	-0.925*** (0.020)	-0.904*** (0.026)
Smallest airline	-0.766*** (0.037)	-0.994*** (0.080)	-0.681*** (0.056)	-0.639*** (0.055)
	Compensated own-fare elasticity			
Largest airline	-0.209*** (0.015)	-0.282*** (0.031)	-0.176*** (0.023)	-0.173*** (0.026)
Smallest airline	-0.499*** (0.037)	-0.720*** (0.079)	-0.429*** (0.056)	-0.371*** (0.055)
	Expenditure elasticity			
Largest airline	1.040*** (0.003)	1.011*** (0.005)	1.056*** (0.005)	1.073*** (0.00001)
Smallest airline	0.904*** (0.007)	0.972*** (0.012)	0.864*** (0.012)	0.844*** (0.00002)

Source: Author calculations using Table 19 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

The own-fare and expenditure elasticities for business travelers in markets with two airlines are reported in Table 26. Calculated elasticities have the expected signs and are statistically significant at the one percent level. The comparison of these elasticities with the ones reported in Table 25 shows slim differences between the two sets. The business price elasticities tend to be lower than the leisure travelers price elasticities. Expenditure elasticity of business travelers' data shows that the largest airline will have higher share of travelers if travel expenditure increases.

Fare and expenditure elasticities for leisure and business travelers for markets with three airlines are reported in Tables 27 & 28, respectively. Table 27 shows leisure travelers' elasticities for distance categories and all observations. All elasticities are significant at the one and five percent levels.

Table 26. Compensated & Uncompensated Own-Fare and Expenditure Elasticities for Business Travelers: Markets with Two Airlines

Airline	Uncompensated own-price elasticity	Compensated own-price elasticity	Expenditure elasticity
Largest airline	-0.931*** (0.048)	-0.202*** (0.034)	1.069*** (0.00003)
Smallest airline	-0.704*** (0.078)	-0.433*** (0.074)	0.853*** (0.00003)

Source: Author calculations using Table 20 and equations 3-5.
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

Table 27 reveals no specific trend as the reported trend of Table 10, however it shows the medium distance is the most fare elastic among distance categories, then short distance. Expenditure elasticity for the second largest and the smallest airline shows a tendency to increase with distance.

Cross-fare elasticities are reported in Appendix B. Uncompensated cross-price elasticities are mostly negative with some are positive. Almost half of these elasticities are significant across estimated equations. Compensated cross-fare elasticities are positive, and different from zero except one.

As Table 28 shows, the business fare elasticity is lower than the average elasticity for markets with three airlines. This is consistent with the theoretical prediction and empirical works cited by Oum et al. (1992), Brons et al. (2001) and Gillen et al. (2004). But caution should be taken here because of the small number of observations used in the estimation.

Table 27. Compensated and Uncompensated Own-Fare Elasticities for Leisure Travelers: Markets with Three Airlines

Airline	All distance	700 miles or less	700-1500 miles	More than 1500 miles
Uncompensated own-fare elasticity				
Largest airline	-0.878***	-0.887***	-0.931***	-0.789***
	(0.034)	(0.093)	(0.058)	(0.061)
Second largest airline	-0.795***	-0.721***	-0.825***	-0.678***
	(0.048)	(0.142)	(0.087)	(0.080)
Smallest airline	-0.707***	-0.474**	-0.786***	-0.642***
	(0.074)	(0.211)	(0.133)	(0.108)
Compensated own-fare elasticity				
Largest airline	-0.246***	-0.197**	-0.285***	-0.176***
	(0.034)	(0.099)	(0.058)	(0.061)
Second largest airline	-0.555***	-0.512***	-0.589***	-0.435***
	(0.041)	(0.130)	(0.070)	(0.066)
Smallest airline	-0.580***	-0.373***	-0.668***	-0.499***
	(0.034)	(0.099)	(0.058)	(0.061)
Expenditure elasticity				
Largest airline	1.106***	1.215***	1.099***	1.130***
	(0.074)	(0.211)	(0.133)	(0.108)
Second largest airline	0.900***	0.772***	0.897***	0.885***
	(0.007)	(0.042)	(0.011)	(0.014)
Smallest airline	0.789***	0.623***	0.791***	0.785***
	(0.010)	(0.062)	(0.017)	(0.018)

Source: Author calculations using Table 21 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

Table 28. Compensated & Uncompensated Own-Fare and Expenditure Elasticities for Business Travelers: Markets with Three Airlines

Airline	Uncompensated own-price elasticity	Compensated own-price elasticity	Expenditure elasticity
Largest airline	-0.668***	-0.173	1.065***
	(0.109)	(0.106)	(0.331)
Second largest airline	-0.771***	-0.416***	1.039***
	(0.096)	(0.117)	(0.028)
Smallest airline	-0.370	-0.220**	0.775***
	(0.332)	(0.106)	(0.033)

Source: Author calculations using Table 22 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

All the estimated elasticities are significant except one, which is close to ten percent significant level. Two of the airlines have expenditure elasticity higher than one.

Own-fare and expenditure elasticities for leisure travelers in markets with four airlines are reported in Table 29. The table shows all the elasticities of different distance categories are different from zero. Uncompensated and compensated own-fare elasticities are negative and more elastic for short distance.

All expenditure elasticities are positive, and above one for largest airline. This airline expenditure elasticity tends to decrease with distance. On the other hand, other airlines' expenditure elasticity tends to increase with distance.

Table 29. Compensated and Uncompensated Own-Fare and Expenditure Elasticities for Leisure Travelers: Markets with Four Airlines

Airline	All distance	700 miles or less	700-1500 miles	More than 1500 miles
Uncompensated own-fare elasticity				
Largest airline	-0.952***	-1.324***	-0.975***	-0.866***
	(0.049)	(0.165)	(0.071)	(0.071)
Second largest airline	-0.918***	-0.961***	-0.884***	-0.921***
	(0.053)	(0.239)	(0.081)	(0.074)
Third largest airline	-0.875***	-1.219***	-0.885***	-0.839***
	(0.062)	(0.308)	(0.093)	(0.085)
Smallest airline	-0.723***	-0.884	-0.654***	-0.764***
	(0.094)	(0.615	(0.004)	(0.1230
Compensated own-fare elasticity				
Largest airline	-0.383***	-0.647***	-0.392***	-0.317***
	(0.049)	(0.183)	(0.071)	(0.070)
Second largest airline	-0.702***	-0.811***	-0.673***	-0.699***
	(0.053)	(0.250)	(0.080)	(0.073)
Third largest airline	-0.740***	-1.111***	-0.756***	-0.698***
	(0.062)	(0.318)	(0.093)	(0.085)
Smallest airline	-0.643***	-0.820	-0.578***	-0.678***
	(0.094)	(0.615	(0.157)	(0.123)

Table 29. *Continued.*

All distance	700 miles or less	700-1500 miles	More than 1500 miles	All distance
	Expenditure elasticity			
Largest airline	1.216***	1.313***	1.218***	1.202***
	(0.014)	(0.065)	(0.022)	(0.018)
Second largest airline	0.864***	0.675***	0.846***	0.885***
	(0.016)	(0.099)	(0.027)	(0.020)
Third largest airline	0.864***	0.675***	0.780***	0.806***
	(0.018)	(0.130)	(0.030)	(0.022)
Smallest airline	0.724***	0.613***	0.719***	0.746***
	(0.017)	(0.179)	(0.035)	(0.024)

Source: Author calculations using Table 23 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

Cross-fare elasticities are reported in Appendix B. Uncompensated elasticities are mostly negative. There are some positive cross-fare elasticity estimates for each estimated equation, but these estimates are not reproducing the same sign in different distances estimations. The second largest and the third largest airlines are substitutes. Compensated cross-fare elasticities are all positive except for short distance estimation.

Comparison of Tables 29 and 11 shows a close similarity between the two tables in term of elasticities absolute value. This may due to the domination of leisure travelers' observation on these markets.

Fare and expenditure elasticities for markets with five-and-more are presented by Table 30. All calculated elasticities are significant at one percent except one. Fare elasticity for markets with five-and-more airlines is more elastic for medium distances than average or long distance. Also, expenditure elasticity tends to increase with distance for all airlines except the largest share airline, for which the tendency is reversed.

Table 30. Compensated and Uncompensated Own-Fare and Expenditure Elasticities for Leisure Travelers: Markets with Five-and-More Airlines

Airline	All distances	700-1500 miles	More than 1500 miles
	Uncompensated own-fare elasticity		
Largest airline	-0.854***	-0.815***	-0.869***
	(0.060)	(0.131)	(0.066)
Second largest airline	-0.975***	-1.091***	-0.936***
	(0.040)	(0.096)	(0.044)
Third largest airline	-0.881***	-0.776***	-0.905***
	(0.036)	(0.089)	(0.040)
Fourth largest airline	-0.875***	-1.043***	-0.820***
	(0.041)	(0.091)	(0.044)
Smallest airline	-0.762***	-0.754	-0.760***
	(0.097)	(0.916)	(0.106)
	Compensated own-fare elasticity		
Largest airline	-0.420***	-0.321***	-0.453***
	(0.060)	(0.129)	(0.066)
Second largest airline	-0.754***	-0.876***	-0.712***
	(0.040)	(0.096)	(0.043)
Third largest airline	-0.731***	-0.652***	-0.747***
	(0.031)	(0.090)	(0.040)
Fourth largest airline	-0.762***	-0.951***	-0.702***
	(0.038)	(0.091)	(0.044)
Smallest share airline	-0.686***	-0.688	-0.681***
	(0.097)	(0.916)	(0.027)
	Expenditure elasticity		
Largest airline	1.185***	1.257***	1.157***
	(0.021)	(0.042)	(0.023)
Second largest airline	0.955***	0.952***	0.960***
	(0.017)	(0.040)	(0.019)
Third largest airline	0.867***	0.761***	0.899***
	(0.018)	(0.042)	(0.020)
Fourth largest airline	0.858***	0.745***	0.889***
	(0.020)	(0.045)	(0.022)
Smallest airline	0.783***	0.689	0.808***
	(0.026)	(0.916)	(0.140)

Source: Author calculations using Table 24 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

Cross-fare elasticity exhibits the same pattern as before: positive compensated cross-fare elasticity, and mostly negative uncompensated cross-fare elasticity. The fourth largest share and the smallest share airlines are substitutes. Comparison of Tables 30 and 12 shows no trend at all.

CHAPTER V

CONCLUSIONS

This dissertation has estimated the fare and expenditure elasticities of demand for domestic air travel in U.S. The literature on demand for air travel generally finds that market can be segmented according to trip distance, reason of travel and trip destination. Also, empirical studies show that estimated fare elasticity will be different based on the time span of the study and the number of airlines serving that city pair.

In spite of the numerous number of air travel demand studies, these studies suffer from many drawbacks such as the fares and attributes of substitutes, basis of functional forms used, time horizon of the study, market aggregation or segmentation, the identification problem and intermodal competition. Also, there have been a few studies that estimate the demand facing each airline. The estimation of fare and expenditure elasticities of air travel demand is an important issue for airlines, public policy and travelers' welfare.

This dissertation addresses the issues of estimating the fare and expenditure elasticities of demand for air travel, and analyzes the factors that produce the differences in estimated elasticity. The dissertation presents the first estimation of domestic air travel demand for U.S. using AIDS within the multistage budgeting approach. This approach requires priori segmentation of products. Besides segmenting the air travel markets according to the reason for travel and trip distance, this dissertation, also, divides the domestic air travel markets into segments according to the number of airlines serving (competition structure) city pairs. The airlines behave differently according to number of competitors. Also, the estimated elasticities from these markets will be different. We divide the air travel market into four different segments of according to number of airlines. This dissertation estimates the demand for air travel by considering the differences among travelers and distances. The model estimated for all distances and across distance categories, then estimated each type of travelers' demand for all distances and across distance categories.

The estimation results show that the compensated own and cross-fare elasticities are always as predicted by theory. The domination of expenditure elasticity in the estimation is the reason for negative uncompensated cross-fare elasticity.

The estimation results show that expenditure has an important effect on the share for every airline, and this effect is measurable and always significant in all estimation. On the other hand, fares have moderate effect on the share of airlines, and it performs poorly in the short distance estimation. Mostly, short distance fare estimates were statistically insignificant.

Uncompensated cross-fare elasticity is mostly negative because expenditure effects outweigh substitution effects. The expenditure elasticity is high for the largest airline and mostly less than unity for other airlines in the markets. These estimates are close to the average or median of previous estimates reported by Gillen et al. (2004), Oum et al. (1992), and Brons et al. (2001). These results indicate that the largest airline will obtain the benefits of expenditure increase, because the travelers are going to shift to that airline.

The expenditure elasticity trends are very interesting; the largest airline expenditure elasticity increases with distance for markets with two and three airlines, and decreases with distance for markets with four and five-and-more airlines. The reverse happens to the other airlines expenditure elasticities. This may be explained by that longer distances, accompanied by higher number of airlines, lead to lessen the domination of largest airline in terms of the expenditure and travelers shares.

Compensated own and cross-fare elasticities are consistent with the theoretical predictions. Own-fare is negative, and cross-fare is positive for almost all estimates. The largest airline has the lowest own-fare compensated elasticity.

Comparing uncompensated own-fare elasticities of different markets with each another show no clear trend when the number of airlines increases. The exclusion of markets with two airlines from comparison gives a general pattern of increasing uncompensated own-fare elasticity as the number of airlines increases. The largest airline uncompensated own-fare elasticity for markets with five-and-more airlines is the only exception of that trend. The conditional uncompensated own-fare elasticity, within each market, tends to be less with trip distance for markets with two and with three airlines. The uncompensated elasticity for markets with four, and five-and-more airlines have similar trend like the other airline markets with some exceptions. The two trends are justified by substitutability factor. As mentioned in Chapter II, longer distances indicate fewer alternatives for air travel, and subsequently less elastic demand. Also, as number of airlines increases in the market, the travelers have more alternative to choose from.

Due to fewness of observations for business travelers, we cannot generalize the result of business fare elasticity. The calculated elasticities were lower than own-fare elasticity of leisure travelers. Observations fewness for business travelers restricts estimating the demand for business travelers properly, and makes it unreliable to generalize the results or to compare them to leisure travelers' demand estimates.

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APPENDIX A

ESTIMATION AND ELASTICITIES: ALL TRAVELERS

Table A1. Estimation Results of Short Trips Distance: Markets with Two Airlines

	Largest airline	Smallest airline
Log(Largest airline average fare)	0.006	-0.006
	(0.022)	(0.022)
Log(Smallest airline average fare)	-0.006	0.006
	(0.022)	(0.022)
Log (Real city pair expenditure)	0.008**	-0.008**
	(0.004)	(0.004)
Constant	0.671***	0.329***
	(0.023)	(0.023)
R-square	0.008	
Chi-square	4.62	
P-value	0.099	
Number of observations	566	566
Share (mean %)	71.83	28.17

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

Table A2. Estimation Results of Medium Trips Distance: Markets with Two Airlines

	Largest airline	Smallest airline
Log(Largest airline average fare)	0.091***	-0.091***
	(0.016)	(0.016)
Log(Smallest airline average fare)	-0.091***	0.091***
	(0.016)	(0.016)
Log (Real city pair expenditure)	0.040***	-0.040***
	(0.003)	(0.003)
Constant	0.502***	0.498***
	(0.018)	(0.018)
R-square	0.17	
Chi-square	157.96	
P-value	0.000	
Number of observations	795	795
Share (mean %)	70.91	29.09

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A3. Estimation Results of Long Trips Distance: Markets with Two Airlines

	Largest share airline	Smallest share airline
Log(Largest share airline average fare)	0.103***	-0.103***
	(0.017)	(0.017)
Log(Smallest share airline average fare)	-0.103***	0.103***
	(0.017)	(0.017)
Log (Real city pair expenditure)	0.046***	-0.046***
	(0.004)	(0.004)
Constant	0.466***	0.534***
	(0.021)	(0.021)
R-square	0.23	
Chi-square	137.12	
P-value	0.000	
Number of observations	466	466
Share (mean %)	68.34	31.66

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

TableA4. Estimation Results of Short Trips Distance: Markets with Three Airlines

	Largest airline	Second largest airline	Smallest airline
Log(Largest airline average fare)	-0.075	0.052	0.022
	(0.068)	(0.044)	(0.035)
Log(Second largest airline average fare)	0.052	-0.045	-0.007
	(0.044)	(0.037)	(0.023)
Log(Smallest airline average fare)	0.022	-0.007	-0.015
	(0.035)	(0.023)	(0.042)
Log (Real city pair expenditure)	0.014	-0.006	-0.008
	(0.010)	(0.007)	(0.005)
Constant	0.505***	0.295***	0.200***
	(0.060)	(0.039)	(0.032)
R-square	0.07	0.02	
Chi-square	3.71	2.48	
P-value	0.294	0.478	
Number of observations	112	112	112
Share (mean %)	58.74	26.14	15.12

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

TableA5. Estimation Results of Medium Trips Distance: Markets with Three Airlines

	Largest airline	Second largest airline	Smallest airline
Log(Largest airline average fare)	0.068** (0.032)	-0.030 (0.022)	-0.038*** (0.015)
Log(Second largest airline average fare)	-0.030 (0.022)	0.040** (0.018)	-0.010 (0.010)
Log(Smallest airline average fare)	-0.038*** (0.015)	-0.010 (0.010)	0.048*** (0.018)
Log (Real city pair expenditure)	0.058*** (0.006)	-0.026*** (0.005)	-0.031*** (0.003)
Constant	0.277*** 0.035)	0.405*** (0.026)	0.319*** (0.017)
R-square	0.19	0.09	
Chi-square	83.31	38.86	
P-value	0.000	0.000	
Number of observations	358	358	358
Share (mean %)	58.63	26.07	15.30

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

TableA6. Estimation Results of Long Trips Distance: Markets with Three Airlines

	Largest airline	Second largest airline	Smallest airline
Log(Largest airline average fare)	0.144*** (0.034)	-0.083*** (0.022)	-0.061*** (0.017)
Log(Second largest airline average fare)	-0.083*** (0.022)	0.084*** (0.018)	-0.001 (0.011)
Log(Smallest airline average fare)	-0.061*** (0.017)	-0.001 (0.011)	0.062*** (0.020)
Log (Real city pair expenditure)	0.071*** (0.008)	-0.033*** (0.005)	-0.038*** (0.004)
Constant	0.189*** (0.037)	0.439*** (0.025)	0.372*** (0.019)
R-square	0.29	0.18	
Chi-square	106.17	61.58	
P-value	0.00	0.00	
Number of observations	256	256	256
Share (mean %)	54.66	27.83	17.43

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A7. Estimation Results of Short Trips Distance: Markets with Four Airlines

	Largest airline	Second largest airline	Third largest airline	Smallest airline
Log(Largest airline average fare)	-0.081 (0.078)	-0.003 (0.046)	0.084* (0.051)	0.0001 (0.041)
Log(Second largest airline average fare)	-0.003 (0.046)	0.047 (0.050)	-0.042 (0.041)	-0.002 (0.029)
Log(Third largest airline average fare)	0.084* (0.051)	-0.042 (0.041)	-0.019 (0.053)	-0.024 (0.032)
Log(Smallest airline average fare)	0.0001 (0.041)	-0.002 (0.029)	-0.024 (0.032)	0.026 (0.059)
Log (Real city pair expenditure)	0.163*** (0.030)	-0.071*** (0.020)	-0.045** (0.022)	-0.047*** (0.018)
Constant	-0.363** (0.160)	0.604*** (0.109)	0.394*** (0.118)	0.364*** (0.096)
R-square	0.78	0.58	0.41	
Chi-square	57.42	17.99	14.95	
P-value	0.00	0.00	0.00	
Number of observations	14	14	14	14
Share (mean %)	51.11	22.12	15.94	10.82

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A8. Estimation Results of Medium Trips Distance: Markets with Four Airlines

	Largest airline	Second largest airline	Third largest airline	Smallest airline
Log(Largest airline average fare)	0.086*** (0.033)	-0.026 (0.020)	-0.046*** (0.015)	-0.014 (0.012)
Log(Second largest airline average fare)	-0.026 (0.020)	0.023 (0.019)	0.017 (0.011)	-0.015 (0.009)
Log(Third largest airline average fare)	-0.046*** (0.015)	0.017 (0.011)	0.031*** (0.011)	-0.002 (0.008)
Log(Smallest airline average fare)	-0.014 (0.012)	-0.015 (0.009)	-0.002 (0.008)	0.032* (0.017)
Log (Real city pair expenditure)	0.102*** (0.010)	-0.037*** (0.007)	-0.035*** (0.005)	-0.030*** (0.003)
Constant	-0.061 (0.053)	0.444*** (0.036)	0.353*** (0.026)	0.264*** (0.019)
R-square	0.36	0.17	0.26	
Chi-square	112.88	40.96	68.91	
P-value	0.00	0.00	0.00	
Number of observations	194	194	194	194
Share (mean %)	47.85	25.14	16.58	10.44

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A9. Estimation Results of Long Trips Distance: Markets with Four Airlines

	Largest airline	Second largest airline	Third largest airline	Smallest airline
Log(Largest airline average fare)	0.072** (0.030)	-0.012 (0.017)	-0.027* (0.014)	-0.033*** (0.009)
Log(Second largest airline average fare)	-0.012 (0.017)	0.015 (0.015)	0.002 (0.009)	-0.004 (0.007)
Log(Third largest airline average fare)	-0.027* (0.014)	0.002 (0.009)	0.015 (0.010)	0.010 (0.006)
Log(Smallest airline average fare)	-0.033*** (0.009)	-0.004 (0.007)	0.010 (0.006)	0.027* (0.014)
Log (Real city pair expenditure)	0.093*** (0.008)	-0.028*** (0.005)	-0.034*** (0.004)	-0.030*** (0.003)
Constant	-0.026 (0.042)	0.398*** (0.026)	0.354*** (0.020)	0.274*** (0.014)
R-square	0.36	0.13	0.25	
Chi-square	148.86	37.17	83.44	
P-value	0.00	0.00	0.00	
Number of observations	255	255	255	255
Share (mean %)	45.85	25.09	17.49	11.58

Standard errors are in parentheses

*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A10. Estimation Results of Medium Distance Trips: Markets with Five-and-More Airlines

	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
Log(Largest airline average fare)	0.061	-0.009	-0.010	-0.010	-0.032**
	(0.054)	(0.026)	(0.020)	(0.018)	(0.016)
Log(Second largest airline average fare)	-0.009	-0.006	-0.013	0.012	0.017*
	(0.026)	(0.021)	(0.012)	(0.010)	(0.010)
Log(Third largest airline average fare)	-0.010	-0.013	0.024*	0.0001	-0.001
	(0.020)	(0.012)	(0.014)	(0.009)	(0.008)
Log(Fourth largest airline average fare)	-0.010	0.012	0.0001	-0.004	0.002
	(0.018)	(0.010)	(0.009)	(0.010)	(0.008)
Log(Smallest airline average fare)	-0.032**	0.017*	-0.001	0.002	0.013
	(0.016)	(0.010)	(0.008)	(0.008)	(0.022)
Log (Real city pair expenditure)	0.092***	-0.006	-0.028***	-0.030***	-0.028***
	(0.016)	(0.009)	(0.006)	(0.006)	(0.005)
Constant	-0.108	0.263***	0.312***	0.285***	0.203***
	(0.086)	(0.050)	(0.033)	(0.030)	(0.027)
R-square (%)	0.30	0.05	0.23	0.26	
Chi-square	36.93	6.34	23.72	31.34	
P-value	0.00	0.27	0.00	0.00	
Number of observations	79	79	79	79	79
Share (mean %)	38.86	22.91	16.23	12.45	9.55

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A11. Estimation Results of Long Distance Trips: Markets with Five-and-More Airlines

	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
Log(Largest airline average fare)	0.061***	0.0001	-0.014	-0.023***	-0.023***
	(0.023)	(0.011)	(0.010)	(0.008)	(0.006)
Log(Second largest airline average fare)	0.0001	0.019	-0.001	-0.008	-0.010**
	(0.011)	(0.010)	(0.006)	(0.006)	(0.005)
Log(Third largest airline average fare)	-0.014	-0.001	0.010	0.006	-0.001
	(0.010)	(0.006)	(0.007)	(0.005)	(0.004)
Log(Fourth largest airline average fare)	-0.023***	-0.008	0.006	0.015***	0.010***
	(0.008)	(0.006)	(0.005)	(0.006)	(0.004)
Log(Smallest airline average fare)	-0.023***	-0.010	-0.001	0.010***	0.024**
	(0.006)	(0.005)	(0.004)	(0.004)	(0.010)
Log (Real city pair expenditure)	0.057***	-0.007	-0.016***	-0.016***	-0.018***
	(0.009)	(0.004)	(0.004)	(0.003)	(0.002)
Constant	0.051	0.270***	0.260***	0.221***	0.203***
	(0.048)	(0.024)	(0.020)	(0.016)	(0.013)
R-square (%)	0.13	0.01	0.06	0.11	
Chi-square	52.26	8.83	20.5	36.11	
P-value	0.00	0.11	0.00	0.00	
Number of observations	301	301	301	301	301
Share (mean %)	36.26	23.25	17.46	13.36	9.67

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A12. Fare and Expenditure Elasticities: Markets with Two Airlines

	Largest airline	Smallest airline
	Uncompensated fare elasticity	
Largest airline	-0.930***	-0.168***
	(0.016)	(0.001)
Smallest airline	-0.331***	-0.738***
	(0.0001)	(0.036)
Expenditure elasticity	1.040***	0.905***
	(0.007)	(0.0001)
	Compensated fare elasticity	
Largest airline	-0.197***	0.471***
	(0.015)	(0.001)
Smallest airline	-0.025***	-0.471***
	(0.0001)	(0.036)

Source: Author's calculations using Table 5 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A13. Fare and Expenditure Elasticities for Short Distance Trips: Markets with Two Airlines

	Largest airline	Smallest airline
	Uncompensated fare elasticity	
Largest airline	-1.000***	-0.001
	(0.032)	(0.006)
Smallest airline	-0.289***	-0.972***
	(0.001)	(0.076)
Expenditure elasticity	1.011***	0.973***
	(0.013)	(0.00002)
	Compensated fare elasticity	
Largest airline	-0.286***	0.685***
	(0.032)	(0.006)
Smallest airline	0.009***	-0.685***
	(0.001)	(0.076)

Source: Author's calculations using Table A1 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A14. Fare and Expenditure Elasticities for Medium Distance Trips: Markets with Two Airlines

	Largest airline	Smallest airline
	Uncompensated fare elasticity	
Largest airline	-0.911*** (0.024)	-0.216*** (0.003)
Smallest airline	-0.335*** (0.003)	-0.645*** (0.057)
Expenditure elasticity	1.057*** (0.00001)	0.861*** (0.005)
	Compensated fare elasticity	
Largest airline	-0.162*** (0.023)	0.395*** (0.003)
Smallest airline	-0.027*** (0.001)	-0.395*** (0.057)

Source: Author's calculations using Table A2 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A15. Fare and Expenditure Elasticities for Long Distance Trips: Markets with Two Airlines

	Largest airline	Smallest airline
	Uncompensated fare elasticity	
Largest airline	-0.896*** (0.025)	-0.225*** (0.003)
Smallest airline	-0.366*** (0.003)	-0.629*** (0.052)
Expenditure elasticity	1.068*** (0.014)	0.854*** (0.014)
	Compensated fare elasticity	
Largest airline	-0.166*** (0.024)	0.359*** (0.003)
Smallest airline	-0.028*** (0.001)	-0.359*** (0.052)

Source: Author's calculations using Table A3 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A16. Fare and Expenditure Elasticities: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity			
Largest airline	-0.902***	-0.107***	-0.172***
	(0.048)	(0.048)	(0.051)
Second largest airline	-0.106***	-0.813***	0.065
	(0.001)	(0.072)	(0.039)
Smallest airline	-0.099***	0.022	-0.684***
	(0.016)	(1.009)	(0.034)
Expenditure elasticity	1.106***	0.898***	0.791***
	(0.007)	(0.010)	(0.072)
Compensated fare elasticity			
Largest airline	-0.269***	0.407***	0.281***
	(0.041)	(0.049)	(0.059)
Second largest airline	0.190***	-0.573***	0.276***
	(0.023)	(0.072)	(0.042)
Smallest airline	0.079***	0.166***	-0.557***
	(0.016)	(0.025)	(0.041)

Source: Author's calculations using Table 6 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A17. Fare and Expenditure Elasticities for short Distance Trips: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity			
Largest airline	-1.141***	0.213	0.180
	(0.169)	(0.169)	(0.233)
Second largest airline	0.083***	-1.166***	-0.034
	(0.006)	(0.277)	(0.156)
Smallest airline	0.034	-0.025	-1.091***
	(0.059)	(1.032)	(0.115)
Expenditure elasticity	1.024***	0.977***	0.944***
	(0.017)	(0.025)	(0.277)
Compensated fare elasticity			
Largest airline	-0.540***	0.787***	0.735***
	(0.142)	(0.169)	(0.230)
Second largest airline	0.350***	-0.910***	0.213
	(0.075)	(0.277)	(0.155)
Smallest airline	0.189***	0.123	-0.948***
	(0.059)	(0.090)	(0.142)

Source: Author's calculations using Table A4 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A18. Fare and Expenditure Elasticities for Medium Distance Trips: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity			
Largest airline	-0.942***	-0.054	-0.128***
	(0.083)	(0.148)	(0.0001)
Second largest airline	-0.076***	-0.821***	-0.013***
	(0.007)	(0.125)	(0.0001)
Smallest airline	-0.080***	-0.024	-0.654***
	(0.026)	(1.014)	(0.054)
Expenditure elasticity	1.098***	0.899***	0.796***
	(0.011)	(0.018)	(0.125)
Compensated fare elasticity			
Largest airline	-0.298***	0.473***	0.338***
	(0.068)	(0.148)	(0.0001)
Second largest airline	0.210***	-0.587***	0.194***
	(0.083)	(0.125)	(0.0001)
Smallest airline	0.088	0.114	-0.533***
	(0.058)	(0.071)	(0.068)

Source: Author's calculations using Table A5 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A19. Fare and Expenditure Elasticities for Long Distance Trips: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
	Uncompensated fare elasticity		
Largest airline	-0.808***	-0.233*	-0.230***
	(0.124)	(0.124)	(0.0001)
Second largest airline	-0.187***	-0.667***	0.056***
	(0.007)	(0.004)	(0.00004)
Smallest airline	-0.134***	0.018	-0.607***
	(0.060))	(1.015)	(0.123)
Expenditure elasticity	1.130***	0.882***	0.780***
	(0.028)	(0.029)	(0.00008)
	Compensated fare elasticity		
Largest airline	-0.190	0.250***	0.196***
	(0.100)	(0.124)	(0.00006)
Second largest airline	0.127	-0.422***	0.273***
	(0.081)	(0.00008)	(0.00004)
Smallest airline	0.063	0.171***	-0.471***
	(0.061)	(0.064)	(0.100)

Source: Author's calculations using Table A6 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A20. Fare and Expenditure Elasticities: Markets with Four Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Smallest airline
Uncompensated fare elasticity				
Largest airline	-0.960***	0.005	-0.080	-0.059
	(0.047)	(0.028)	(0.059)	(0.060)
Second largest airline	-0.083***	-0.899***	0.097***	-0.023
	(0.028)	(0.052)	(0.040)	(0.049)
Third largest airline	-0.101***	0.052**	-0.842***	0.066
	(0.022)	(0.027)	(0.059)	(0.040)
Smallest airline	-0.068***	-0.027	0.042***	-0.705***
	(0.015)	(0.023)	(0.010)	(0.094)
Expenditure elasticity	1.213***	0.868***	0.868***	0.721***
	(0.013)	(0.016)	(0.018)	(0.022)
Compensated fare elasticity				
Largest airline	-0.392***	0.412***	0.290***	0.279***
	(0.046)	(0.052)	(0.059)	(0.064)
Second largest airline	0.220***	-0.682***	0.294***	0.157***
	(0.006)	(0.052)	(0.040)	(0.053)
Third largest airline	0.106***	0.201***	-0.707***	0.189***
	(0.022)	(0.027)	(0.059)	(0.043)
Smallest airline	0.066***	0.070***	0.129***	-0.625***
	(0.015)	(0.023)	(0.028)	(0.094)

Source: Author's calculations using Table 7 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A21. Fare and Expenditure Elasticities for Short Distance Trips: Markets with Four Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Smallest airline
Uncompensated fare elasticity				
Largest airline	-1.321***	0.148	0.672***	0.224
	(0.137)	(0.188)	(0.283)	(0.384)
Second largest airline	-0.077	-0.716***	-0.200	0.078
	(0.092)	(0.197)	(0.255)	(0.202)
Third largest airline	0.114	-0.137	-1.075***	-0.149
	(0.103)	(0.186)	(0.307)	(0.247)
Smallest airline	-0.034	0.025	-0.189	-0.715
	(0.079)	(0.131)	(0.196)	(0.548)
Expenditure elasticity	1.318***	0.680***	0.680***	0.562***
	(0.058)	(0.091)	(0.137)	(0.163)
Compensated fare elasticity				
Largest airline	-0.647***	0.495***	1.041***	0.512
	(0.152)	(0.206)	(0.317)	(0.376)
Second largest airline	0.214***	-0.565***	-0.040	0.202
	(0.023)	(0.206)	(0.255)	(0.271)
Third largest airline	0.325***	-0.029	-0.960***	-0.060
	(0.099)	(0.184)	(0.317)	(0.292)
Smallest airline	0.108	0.099	-0.111	-0.654
	(0.080)	(0.133)	(0.198)	(0.547)

Source: Author’s calculations using Table A7 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A22. Fare and Expenditure Elasticities for Medium Distance Trips: Markets with Four Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Smallest airline
Uncompensated fare elasticity				
Largest airline	-0.923***	-0.031***	-0.174**	-0.001
	(0.070)	(0.002)	(0.092)	(0.069)
Second largest airline	-0.107***	-0.870***	0.158***	-0.073
	(0.043)	(0.081)	(0.065)	(0.063)
Third largest airline	-0.131***	0.093***	-0.777***	0.023***
	(0.032)	(0.043)	(0.092)	(0.0001)
Smallest airline	-0.052***	-0.044	0.008	-0.664***
	(0.024)	(0.037)	(0.039)	(0.162)
Expenditure elasticity	1.213***	0.853***	0.786***	0.716***
	(0.021)	(0.027)	(0.029)	(0.033)
Compensated fare elasticity				
Largest airline	-0.342***	0.377***	0.202***	0.343***
	(0.069)	(0.081)	(0.092)	(0.111)
Second largest airline	0.198***	-0.656***	0.356***	0.105
	(0.010)	(0.081)	(0.065)	(0.090)
Third largest airline	0.070***	0.235***	-0.647***	0.141**
	(0.032)	(0.043)	(0.092)	(0.075)
Smallest airline	0.074***	0.045	0.090**	-0.590***
	(0.024)	(0.037)	(0.047)	(0.161)

Source: Author's calculations using Table A8 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A23. Fare and Expenditure Elasticities for Long Distance Trips: Markets with Four Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Smallest airline
Uncompensated fare elasticity				
Largest airline	-0.937***	0.004	-0.063	-0.163***
	(0.066)	(0.038)	(0.081)	(0.078)
Second largest airline	-0.077***	-0.914***	0.061	0.026
	(0.037)	(0.070)	(0.052)	(0.062)
Third largest airline	-0.094***	0.028	-0.882***	0.132***
	(0.030)	(0.037)	(0.080)	(0.054)
Smallest airline	-0.094***	-0.005	0.110***	-0.737***
	(0.020)	(0.029)	(0.026)	(0.117)
Expenditure elasticity	1.202***	0.886***	0.804***	0.721***
	(0.017)	(0.020)	(0.022)	(0.026)
Compensated fare elasticity				
Largest airline	-0.386***	0.410***	0.305***	0.177***
	(0.065)	(0.069)	(0.080)	(0.081)
Second largest airline	0.224***	-0.691***	0.263***	0.212***
	(0.008)	(0.069)	(0.052)	(0.064)
Third largest airline	0.116***	0.183***	-0.742***	0.262***
	(0.030)	(0.037)	(0.080)	(0.056)
Smallest airline	0.045***	0.098***	0.203***	-0.651***
	(0.020)	(0.030)	(0.037)	(0.117)

Source: Author's calculations using Table A9 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A24. Fare and Expenditure Elasticities: Markets-with-Five-and-More Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
			Uncompensated fare elasticity		
Largest airline	-0.894***	-0.012	-0.037	-0.105*	-0.167***
	(0.058)	(0.044)	(0.051)	(0.055)	(0.057)
Second largest airline	-0.056***	-0.952***	0.021	0.032	0.018
	(0.028)	(0.039)	(0.032)	(0.037)	(0.039)
Third largest airline	-0.065***	0.003	-0.916***	0.054	0.020
	(0.025)	(0.024)	(0.037)	(0.032)	(0.039)
Fourth largest airline	-0.079***	0.004	0.037	-0.910***	0.104***
	(0.020)	(0.021)	(0.024)	(0.039)	(0.034)
Smallest airline	-0.081***	-0.009	0.001	0.070***	-0.765***
	(0.012)	(0.018)	(0.023)	(0.025)	(0.095)
Expenditure elasticity	1.176***	0.967***	0.862***	0.859***	0.789***
	(0.021)	(0.017)	(0.018)	(0.020)	(0.023)
			Compensated fare elasticity		
Largest airline	-0.461***	0.344***	0.281***	0.212***	0.124***
	(0.059)	(0.044)	(0.051)***	(0.055)	(0.062)
Second largest airline	0.216***	-0.728***	0.220***	0.231***	0.201***
	(0.028)	(0.038)	(0.031)	(0.037)	(0.045)
Third largest airline	0.136***	0.169***	-0.768***	0.202***	0.155***
	(0.024)	(0.023)	(0.031)	(0.031)	(0.043)
Fourth largest airline	0.076***	0.131***	0.150***	-0.797***	0.208***
	(0.020)	(0.021)	(0.024)	(0.037)	(0.037)
Smallest airline	0.032***	0.084***	0.084***	0.152***	-0.689***
	(0.016)	(0.019)	(0.024)	(0.027)	(0.095)

Source: Author's calculations using Table 8 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A25. Fare and Expenditure Elasticities for Medium Distance Trips: Markets with Five-and-More Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
Uncompensated fare elasticity					
Largest airline	-0.934	-0.029	0.005	0.009	-0.218
	(0.534)	(0.112)	(0.123)	(0.147)	(0.168)
Second largest airline	-0.078	-1.022***	-0.044	0.153*	0.243***
	(0.066)	(0.424)	(0.071)	(0.081)	(0.100)
Third largest airline	-0.064	-0.054	-0.821***	0.035	0.042
	(0.052)	(0.052)	(0.375)	(0.072)	(0.084)
Fourth largest airline	-0.056	0.057	0.018	-0.999***	0.060
	(0.048)	(0.045)	(0.055)	(0.309)	(0.082)
Smallest airline	-0.104***	0.076	0.013	0.040	-0.831
	(0.040)	(0.042)	(0.050)	(0.063)	(0.728)
Expenditure elasticity	1.237***	0.973***	0.776***	0.761***	0.704***
	(0.159)	(0.187)	(0.167)	(0.164)	(0.162)
Compensated fare elasticity					
Largest airline	-0.454	0.349***	0.307***	0.305***	0.056
	(0.535)	(0.111)	(0.123)	(0.148)	(0.169)
Second largest airline	0.206***	-0.799*	0.134***	0.328***	0.404***
	(0.066)	(0.424	(0.072)	(0.081)	(0.102)
Third largest airline	0.137***	0.104***	-0.695***	0.158***	0.156*
	(0.051)	(0.051)	(0.320)	(0.071)	(0.085)
Fourth largest airline	0.098	0.178***	0.115***	-0.905***	0.148
	(0.047)	(0.044)	(0.054)	(0.299)	(0.083)
Smallest airline	0.014	0.168***	0.087	0.113*	-0.764
	(0.042)	(0.043)	(0.050)	(0.064)	(0.728)

Source: Author's calculations using Table A10 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table A26. Fare and Expenditure Elasticities for Long Distance Trips: Markets with Five-and-More Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
Uncompensated fare elasticity					
Largest airline	-0.889***	0.010	-0.048	-0.133***	-0.170***
	(0.064)	(0.046)	(0.055)	(0.058)	(0.061)
Second largest airline	-0.037	-0.912***	0.014	-0.029	-0.057
	(0.031)	(0.042)	(0.035)	(0.043)	(0.047)
Third largest airline	-0.066***	0.0001	-0.927***	0.067*	0.022
	(0.028)	(0.026)	(0.041)	(0.036)	(0.037)
Fourth largest airline	-0.086***	-0.028	0.048*	-0.873***	0.128***
	(0.022)	(0.025)	(0.027)	(0.045)	(0.037)
Smallest airline	-0.079***	-0.039*	0.003	0.086***	-0.736***
	(0.013)	(0.021)	(0.022)	(0.028)	(0.102)
Expenditure elasticity	1.156***	0.969***	0.883***	0.883***	0.812***
	(0.024)	(0.019)	(0.021)	(0.022)	(0.023)
Compensated fare elasticity					
Largest airline	-0.470***	0.361***	0.273***	0.187***	0.124*
	(0.064)	(0.047)	(0.056)	(0.059)	(0.066)
Second largest airline	0.232***	-0.687***	0.219***	0.176***	0.132***
	(0.030)	(0.042)	(0.034)	(0.042)	(0.052)
Third largest airline	0.136***	0.169***	-0.773***	0.221***	0.164***
	(0.027)	(0.026)	(0.034)	(0.035)	(0.041)
Fourth largest airline	0.069***	0.101***	0.166***	-0.756***	0.237***
	(0.022)	(0.024)	(0.027)	(0.042)	(0.041)
Smallest airline	0.033*	0.055***	0.088***	0.171***	-0.658***
	(0.018)	(0.022)	(0.023)	(0.029)	(0.102)

Source: Author's calculations using Table A11 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

APPENDIX B

ESTIMATION RESULTS AND ELASTICITIES: LIESURE TRAVELERS

Table B1. Estimation Results of Short Distance Trips: Markets with Two Airlines

	Largest airline	Smallest airline
Log(Largest airline average fare)	-0.001	0.001
	(0.022)	(0.022)
Log(Smallest airline average fare)	0.001	-0.001
	(0.022)	(0.022)
Log (Real city pair expenditure)	0.008**	-0.008**
	(0.004)	(0.004)
Constant	0.672***	0.328***
	(0.023)	(0.0001)
R-square	0.01	
Chi-square	4.46	
P-value	0.10	
Number of observations	564	564
Share (mean %)	71.84	28.16

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

Table B2. Estimation Results of Medium Distance Trips: Markets with Two Airlines

	Largest airline	Smallest airline
Log(Largest airline average fare)	0.082***	-0.082***
	(0.016)	(0.016)
Log(Smallest airline average fare)	-0.082***	0.082***
	(0.016)	(0.016)
Log (Real city pair expenditure)	0.040***	-0.040***
	(0.003)	(0.003)
Constant	0.506***	0.494***
	(0.018)	(0.018)
R-square	0.16	
Chi-square	145.52	
P-value	0.00	
Number of observations	787	787
Share (mean %)	70.85	29.15

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B3. Estimation Results of Long Distance Trips: Markets with Two Airlines

	Largest airline	Smallest airline
Log(Largest airline average fare)	0.099***	-0.099***
	(0.017)	(0.017)
Log(Smallest airline average fare)	-0.099***	0.099***
	(0.017)	(0.017)
Log (Real city pair expenditure)	0.050***	-0.050***
	(0.005)	(0.005)
Constant	0.451***	0.549***
	(0.021)	(0.021)
R-square	0.24	
Chi-square	145.09	
P-value	0.00	
Number of observations	464	464
Share (mean %)	68.19	31.81

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B4. Estimation Results of Short Distance Trips: Markets with Three Airlines

	Largest airline	Second largest airline	Smallest airline
Log(Largest airline average fare)	0.134**	-0.059	-0.075**
	(0.056)	(0.040)	(0.028)
Log(Secondlargest airline average fare)	-0.059	0.059	0.0001
	(0.040)	(0.035)	(0.020)
Log(Smallest airline average fare)	-0.075**	0.0001	0.075**
	(0.028)	(0.020)	(0.034)
Log (Real city pair expenditure)	0.122***	-0.062***	-0.061***
	(0.024)	(0.017)	(0.013)
Constant	-0.020	0.564***	0.455***
	(0.115)	(0.080)	(0.062)
R-square	0.01	0.01	
Chi-square	27.13	15.31	
P-value	0.00	0.00	
Number of observations	75	75	75
Share (mean %)	56.82	27.07	16.11

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B5. Estimation Results of Medium Distance Trips: Markets with Three Airlines

	Largest airline	Second largest airline	Smallest airline
Log(Largest airline average fare)	0.075** (0.034)	-0.043* (0.023)	-0.032* (0.016)
Log(Second largest airline average fare)	-0.043* (0.023)	0.039* (0.019)	0.004 (0.011)
Log(Smallest airline average fare)	-0.032** (0.016)	0.004 (0.011)	0.027 (0.020)
Log (Real city pair expenditure)	0.058*** (0.006)	-0.027*** (0.005)	-0.031*** (0.003)
Constant	0.273*** (0.035)	0.410*** (0.025)	0.317*** (0.017)
R-square	0.19	0.10	
Chi-square	85.85	40.20	
P-value	0.00	0.00	
Number of observations	356	356	356
Share (mean %)	58.80	26.31	14.89

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B6. Estimation Results of Long Distance Trips: Markets with Three Airlines

	Largest airline	Second largest airline	Smallest airline
Log(Largest airline average fare)	0.153*** (0.033)	-0.087*** (0.022)	-0.066*** (0.016)
Log(Second largest airline average fare)	-0.087*** (0.022)	0.080*** (0.018)	0.007 (0.012)
Log(Smallest airline average fare)	-0.066*** (0.016)	0.007 (0.012)	0.058*** (0.020)
Log (Real city pair expenditure)	0.071*** (0.008)	-0.031*** (0.005)	-0.039*** (0.004)
Constant	0.189*** (0.037)	0.432*** (0.025)	0.379*** (0.018)
R-square	0.30	0.17	
Chi-square	109.81	56.07	
P-value	0.00	0.00	
Number of observations	255	255	255
Share (mean %)	54.28	27.44	18.28

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B7. Estimation Results of Short Distance Trips: Markets with Four Airlines

	Largest airline	Second largest airline	Third Largest airline	Smallest airline
Log(Largest airline average fare)	-0.084 (0.094)	0.003 (0.056)	0.057 (0.050)	0.023 (0.047)
Log(Second largest airline average fare)	0.003 (0.056)	-0.007 (0.059)	0.010 (0.037)	-0.006 (0.034)
Log(Third largest airline average fare)	0.057 (0.050)	0.010 (0.037)	-0.042 (0.040)	-0.026 (0.029)
Log(Smallest airline average fare)	0.023 (0.047)	-0.006 (0.034)	-0.026 (0.029)	0.008 (0.065)
Log (Real city pair expenditure)	0.161*** (0.034)	-0.072*** (0.022)	-0.048** (0.020)	-0.041** (0.019)
Constant	-0.342* (0.183)	0.609*** (0.120)	0.410*** (0.110)	0.323*** (0.103)
R-square	0.75	0.55	0.52	
Chi-square	47.68	16.30	15.21	
P-value	0.00	0.00	0.00	
Number of observations	14	14	14	14
Share (mean %)	51.55	22.29	15.64	10.53

Standard errors are in parentheses

*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B8. Estimation Results of Medium Distance Trips: Markets with Four Airlines

	Largest airline	Second largest airline	Third largest airline	Smallest airline
Log(Largest airline average fare)	0.062* (0.034)	-0.020 (0.020)	-0.028* (0.016)	-0.014 (0.011)
Log(Second largest airline average fare)	-0.020 (0.020)	0.019 (0.018)	0.017 (0.010)	-0.017* (0.009)
Log(Third largest airline average fare)	-0.028* (0.016)	0.017* (0.010)	0.013 (0.012)	-0.002 (0.008)
Log(Smallest airline average fare)	-0.014 (0.011)	-0.017 (0.009)	-0.002 (0.008)	0.033** (0.017)
Log (Real city pair expenditure)	0.104 (0.010)	-0.038*** (0.007)	-0.036*** (0.005)	-0.030*** (0.004)
Constant	-0.072 (0.055)	0.450*** (0.035)	0.357*** (0.026)	0.265*** (0.019)
R-square	0.35	0.17	0.24	
Chi-square	103.80	44.04	61.83	
P-value	0.00	0.00	0.00	
Number of Observations	191	191	191	191
Share (mean %)	47.88	24.97	16.59	10.55

Standard errors are in parentheses

*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B9. Estimation Results of Long Distance Trips: Markets with Four Airlines

	Largest airline	Second largest airline	Third Largest airline	Smallest airline
Log(Largest airline average fare)	0.103*** (0.032)	-0.024 (0.018)	-0.045*** (0.015)	-0.034*** (0.010)
Log(Second largest airline average fare)	-0.024 (0.018)	0.013 (0.016)	0.012 (0.009)	0.0004 (0.008)
Log(Third largest airline average fare)	-0.045*** (0.015)	0.012 (0.009)	0.022** (0.011)	0.011 (0.007)
Log(Smallest airline average fare)	-0.034*** (0.010)	0.0004 (0.008)	0.011 (0.007)	0.024 (0.014)
Log (Real city pair expenditure)	0.092*** (0.008)	-0.029*** (0.005)	-0.034*** (0.004)	-0.030*** (0.003)
Constant	-0.026 (0.042)	0.401*** (0.026)	0.354*** (0.020)	0.272*** (0.014)
R-square	0.36	0.13	0.26	
Chi-square	149.22	38.62	90.81	
P-value	0.00	0.00	0.00	
Number of observations	253	253	253	253
Share (mean %)	45.71	25.12	17.55	11.62

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B10. Estimation Results of Medium Distance Trips: Markets with Five-and-More Airlines

	Largest airline	Second largest airline	Third Largest airline	Fourth largest airline	Smallest airline
Log(Largest airline average fare)	0.112**	-0.041*	-0.022	-0.018	-0.031
	(0.051)	(0.024)	(0.020)	(0.017)	(0.066)
Log(Second largest airline average fare)	-0.041*	-0.023	0.012	0.038***	0.015
	(0.024)	(0.022)	(0.013)	(0.011)	(0.039)
Log(Third largest airline average fare)	-0.022	0.012	0.032**	-0.014	-0.007
	(0.020)	(0.013)	(0.015)	(0.009)	(0.032)
Log(Fourth largest airline average fare)	-0.018	0.038***	-0.014	-0.009	0.004
	(0.017)	(0.011)	(0.009)	(0.011)	(0.027)
Log(Smallest airline average fare)	-0.031	0.015	-0.007	0.004	0.021
	(0.066)	(0.039)	(0.032)	(0.027)	(0.088)
Log (Real city pair expenditure)	0.101***	-0.011	-0.029***	-0.031***	-0.030***
	(0.017)	(0.009)	(0.007)	(0.005)	(0.005)
Constant	0.151*	0.285***	0.320***	0.290***	0.203***
	(0.090)	(0.049)	(0.037)	(0.030)	(0.047)
R-square	0.35	0.10	0.30	0.34	
Chi-square	46.54	13.78	32.56	50.83	
P-value	0.00	0.01	0.00	0.00	
Number of observations	76	76	76	76	76
Share (mean %)	39.27	22.65	16.25	12.25	9.57

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B11. Estimation Results of Long Distance Trips: Markets with Five-and-More Airlines

	Largest airline	Second largest airline	Third Largest airline	Fourth largest airline	Smallest airline
Log(Largest airline average fare)	0.068***	0.004	-0.015	-0.028***	-0.028***
	(0.024)	(0.011)	(0.010)	(0.008)	(0.007)
Log(Second largest airline average fare)	0.004	0.013	-0.005	-0.006	-0.005
	(0.011)	(0.010)	(0.006)	(0.006)	(0.005)
Log(Third largest airline average fare)	-0.015	-0.005	0.014**	0.003	0.002
	(0.010)	(0.006)	(0.007)	(0.005)	(0.004)
Log(Fourth largest airline average fare)	-0.028***	-0.006	0.003	0.022***	0.010***
	(0.008)	(0.006)	(0.005)	(0.006)	(0.004)
Log(Smallest airline average fare)	-0.028***	-0.005	0.002	0.010***	0.022***
	(0.007)	(0.005)	(0.004)	(0.004)	(0.010)
Log (Real city pair expenditure)	0.057***	-0.009**	-0.013***	-0.015***	-0.019***
	(0.008)	(0.004)	(0.003)	(0.003)	(0.003)
Constant	0.050	0.283***	0.249***	0.216***	0.203***
	(0.045)	(0.023)	(0.019)	(0.016)	(0.014)
R-square	0.15	0.01	0.06	0.12	
Chi-square	60.84	8.06	19.07	41.86	
P-value	0.00	0.15	0.00	0.00	
Number of observations	305	305	305	305	305
Share (mean %)	36.20	23.32	17.55	13.37	9.80

Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B12. Leisure Travelers' Fare and Expenditure Elasticities: Markets with Two Airlines

Airline	Largest airline	Smallest airline
Uncompensated fare elasticity		
Largest airline	-0.942*** (0.016)	-0.138*** (0.0002)
Smallest airline	-0.319*** (0.0002)	-0.766*** (0.037)
Expenditure elasticity	1.040*** (0.003)	0.904*** (0.007)
Compensated fare elasticity		
Largest airline	-0.209*** (0.015)	0.499*** (0.001)
Smallest airline	-0.012*** (0.0002)	-0.499*** (0.037)

Source: Author's calculations using Table 17 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B13. Leisure Travelers' Fare and Expenditure Elasticities for Short Distance Trips: Markets with Two Airlines

Airline	Largest airline	Smallest airline
Uncompensated fare elasticity		
Largest airline	-1.009*** (0.031)	0.022*** (0.0001)
Smallest airline	-0.262*** (0.001)	-0.994*** (0.080)
Expenditure elasticity	1.011*** (0.005)	0.972*** (0.012)
Compensated fare elasticity		
Largest airline	-0.282*** (0.031)	0.720*** (0.006)
Smallest airline	0.022*** (0.001)	-0.720*** (0.079)

Source: Author's calculations using Table B1 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B14. Leisure Travelers' Fare and Expenditure Elasticities for Medium Distance Trips: Markets with Two Airlines

Airline	Largest airline	Smallest airline
Uncompensated fare elasticity		
Largest airline	-0.925*** (0.024)	-0.183*** (0.003)
Smallest airline	-0.323*** (0.001)	-0.681*** (0.056)
Expenditure elasticity	1.056*** (0.005)	0.864*** (0.012)
Compensated fare elasticity		
Largest airline	-0.176*** (0.023)	0.429*** (0.003)
Smallest airline	-0.015*** (0.001)	-0.429*** (0.056)

Source: Author's calculations using Table B2 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B15. Leisure Travelers' Fare and Expenditure Elasticities for Long Distance Trips: Markets with Two Airlines

Airline	Largest airline	Smallest airline
Uncompensated fare elasticity		
Largest airline	-0.904*** (0.026)	-0.205*** (0.003)
Smallest airline	-0.356*** (0.001)	-0.639*** (0.055)
Expenditure elasticity	1.073*** (0.00002)	0.844*** (0.00002)
Compensated fare elasticity		
Largest airline	-0.173*** (0.026)	0.371*** (0.019)
Smallest airline	-0.014*** (0.001)	-0.371*** (0.055)

Source: Author's calculations using Table B3 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B16. Leisure Travelers' Fare and Expenditure Elasticities: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity			
Largest airline	-0.878***	-0.150***	-0.185***
	(0.034)	(0.048)	(0.002)
Second largest airline	-0.125***	-0.795***	0.104***
	(0.001)	(0.048)	(0.040)
Smallest airline	-0.103***	0.045	-0.707***
	(0.014)	(1.007)	(0.074)
Expenditure elasticity	1.106***	0.900***	0.789***
	(0.074)	(0.007)	(0.010)
Compensated fare elasticity			
Largest airline	-0.246***	0.365***	0.266***
	(0.034)	(0.049)	(0.060)
Second largest airline	0.171***	-0.555***	0.314***
	(0.023)	(0.041)	(0.043)
Smallest airline	0.075***	0.190***	-0.580***
	(0.017)	(0.026)	(0.034)

Source: Author's calculations using Table 18 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B17. Leisure Travelers' Fare and Expenditure Elasticities for short Distance Trips: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity			
Largest airline	-0.887***	-0.088	-0.251***
	(0.093)	(0.139)	(0.028)
Second largest airline	-0.162***	-0.721***	0.102
	(0.006)	(0.142)	(0.071)
Smallest airline	-0.167***	0.036	-0.474***
	(0.048)	(1.024)	(0.211)
Expenditure elasticity	1.215***	0.772***	0.623***
	(0.211)	(0.042)	(0.062)
Compensated fare elasticity			
Largest airline	-0.197**	0.351***	0.103
	(0.099)	(0.147)	(0.171)
Second largest airline	0.167***	-0.512***	0.270***
	(0.070)	(0.130)	(0.123)
Smallest airline	0.029	0.161***	-0.373***
	(0.049)	(0.073)	(0.099)

Source: Author's calculations using Table B4 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B18. Leisure Travelers' Fare and Expenditure Elasticities for Medium Distance Trips: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity			
Largest airline	-0.931***	-0.103	-0.089
	(0.058)	(0.088)	(0.084)
Second largest airline	-0.099***	-0.825***	0.084
	(0.002)	(0.087)	(0.066)
Smallest airline	-0.068***	0.032	-0.786***
	(0.028)	(1.015)	(0.133)
Expenditure elasticity	1.099***	0.897***	0.791***
	(0.133)	(0.011)	(0.017)
Compensated fare elasticity			
Largest airline	-0.285***	0.424***	0.376***
	(0.058)	(0.087)	(0.111)
Second largest airline	0.190***	-0.589***	0.292***
	(0.039)	(0.070)	(0.074)
Smallest airline	0.095***	0.165***	-0.668***
	(0.028)	(0.042)	(0.058)

Source: Author's calculations using Table B5 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B19. Leisure Travelers' Fare and Expenditure Elasticities for Long Distance Trips: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity			
Largest airline	-0.789***	-0.256***	-0.243***
	(0.061)	(0.080)	(0.036)
Second largest airline	-0.196***	-0.678***	0.100
	(0.002)	(0.080)	(0.062)
Smallest airline	-0.145***	0.048	-0.642***
	(0.029)	(1.015)	(0.108)
Expenditure elasticity	1.130***	0.885***	0.785***
	(0.108)	(0.014)	(0.018)
Compensated fare elasticity			
Largest airline	-0.176***	0.225***	0.184***
	(0.061)	(0.079)	(0.088)
Second largest airline	0.114***	-0.435***	0.315***
	(0.040)	(0.066)	(0.063)
Smallest airline	0.062***	0.210***	-0.499***
	(0.030)	(0.042)	(0.061)

Source: Author's calculations using Table B6 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B20. Leisure Travelers' Fare and Expenditure Elasticities: Markets with Four Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Smallest airline
Uncompensated fare elasticity				
Largest airline	-0.952*** (0.049)	-0.003 (0.054)	-0.086*** (0.062)	-0.064 (0.061)
Second largest airline	-0.089*** (0.028)	-0.918*** (0.053)	0.132*** (0.040)	-0.012 (0.047)
Third largest airline	-0.105*** (0.015)	0.077*** (0.027)	-0.875*** (0.062)	0.074 (0.042)
Smallest airline	-0.070*** (0.015)	-0.021 (0.022)	0.051*** (0.012)	-0.723*** (0.094)
Expenditure elasticity	1.216*** (0.014)	0.864*** (0.016)	0.864*** (0.018)	0.724*** (0.017)
Compensated fare elasticity				
Largest airline	-0.383*** (0.049)	0.402*** (0.053)	0.282*** (0.062)	0.275*** (0.066)
Second largest airline	0.214*** (0.006)	-0.702*** (0.053)	0.329*** (0.040)	0.169*** (0.050)
Third largest airline	0.103*** (0.023)	0.225*** (0.027)	-0.740*** (0.062)	0.198*** (0.044)
Smallest airline	0.066*** (0.016)	0.075*** (0.022)	0.139*** (0.029)	-0.643*** (0.094)

Source: Author's calculations using Table 19 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B21. Leisure Travelers' Fare and Expenditure Elasticities for Short Distance Trips: Markets with Four Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Smallest airline
Uncompensated fare elasticity				
Largest airline	-1.324***	0.181	0.525*	0.421
	(0.165)	(0.229)	(0.282)	(0.448)
Second largest airline	-0.064	-0.961***	0.134	0.032
	(0.111)	(0.239)	(0.236)	(0.315)
Third largest airline	0.062	0.096	-1.219***	-0.182
	(0.101)	(0.170)	(0.308)	(0.277)
Smallest airline	0.012	0.009	-0.210	-0.884
	(0.092)	(0.151)	(0.184)	(0.615)
Expenditure elasticity	1.313***	0.675***	0.675***	0.613***
	(0.065)	(0.099)	(0.130)	(0.179)
Compensated fare elasticity				
Largest airline	-0.647***	0.529***	0.881***	0.738
	(0.183)	(0.250)	(0.318)	(0.448)
Second largest airline	0.229***	-0.811***	0.288	0.169
	(0.029)	(0.250)	(0.236)	(0.319)
Third largest airline	0.267***	0.202	-1.111***	-0.086
	(0.096)	(0.165)	(0.318)	(0.276)
Smallest airline	0.151	0.080	-0.137	-0.820
	(0.092)	(0.150)	(0.186)	(0.615)

Source: Author's calculations using Table B7 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B22. Leisure Travelers' Fare and Expenditure Elasticities for Medium Distance Trips: Markets with Four Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Smallest airline
Uncompensated fare elasticity				
Largest airline	-0.975***	-0.005	-0.063	-0.001
	(0.071)	(0.081)	(0.093)	(0.065)
Second largest airline	-0.095***	-0.884***	0.158***	-0.090
	(0.042)	(0.081)	(0.063)	(0.058)
Third largest airline	-0.094***	0.094***	-0.885***	0.025
	(0.033)	(0.042)	(0.093)	(0.073)
Smallest airline	-0.053***	-0.051	0.010	-0.654***
	(0.024)	(0.036)	(0.040)	(0.004)
Expenditure elasticity	1.218***	0.846***	0.780***	0.719***
	(0.022)	(0.027)	(0.030)	(0.035)
Compensated fare elasticity				
Largest airline	-0.392***	0.400***	0.311***	0.343***
	(0.071)	(0.080)	(0.093)	(0.108)
Second largest airline	0.209***	-0.673***	0.353***	0.090
	(0.010)	(0.080)	(0.063)	(0.086)
Third largest airline	0.108***	0.235***	-0.756***	0.145*
	(0.032)	(0.042)	(0.093)	(0.075)
Smallest airline	0.076***	0.038	0.092***	-0.578***
	(0.020)	(0.030)	(0.037)	(0.117)

Source: Author's calculations using Table B8 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B23. Leisure Travelers' Fare and Expenditure Elasticities for Long Distance Trips: Markets with Four Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Smallest airline
Uncompensated fare elasticity				
Largest airline	-0.866***	-0.043	-0.168**	-0.180***
	(0.071)	(0.075)	(0.086)	(0.041)
Second largest airline	-0.103***	-0.921***	0.116***	0.061**
	(0.040)	(0.074)	(0.053)	(0.031)
Third largest airline	-0.134***	0.067*	-0.839***	0.139***
	(0.033)	(0.037)	(0.085)	(0.055)
Smallest airline	-0.099***	0.012	0.116***	-0.764***
	(0.022)	(0.030)	(0.027)	(0.123)
Expenditure elasticity	1.202***	0.885***	0.806***	0.746***
	(0.018)	(0.020)	(0.022)	(0.024)
Compensated fare elasticity				
Largest airline	-0.317***	0.361***	0.201***	0.161***
	(0.070)	(0.073)	(0.085)	(0.087)
Second largest airline	0.199***	-0.699***	0.319***	0.248***
	(0.008)	(0.073)	(0.053)	(0.065)
Third largest airline	0.077***	0.223***	-0.698***	0.269***
	(0.033)	(0.037)	(0.085)	(0.057)
Smallest airline	0.041*	0.115***	0.210***	-0.678***
	(0.022)	(0.030)	(0.038)	(0.123)

Source: Author's calculations using Table B9 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B24. Leisure Travelers' Fare and Expenditure Elasticities: Markets with Five-and-More Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
			Uncompensated fare elasticity		
Largest airline	-0.854*** (0.060)	-0.011 (0.045)	-0.065 (0.051)	-0.145*** (0.057)	-0.211*** (0.060)
Second largest airline	-0.060*** (0.029)	-0.975*** (0.040)	0.025 (0.031)	0.062 (0.038)	0.041 (0.042)
Third largest airline	-0.080*** (0.025)	0.009 (0.024)	-0.881*** (0.036)	0.023 (0.033)	0.036 (0.036)
Fourth largest airline	-0.095*** (0.021)	0.022 (0.022)	0.013 (0.025)	-0.875*** (0.041)	0.114*** (0.034)
Smallest airline	-0.095*** (0.013)	0.0002 (0.019)	0.009 (0.022)	0.077*** (0.026)	-0.762*** (0.097)
Expenditure elasticity	1.185*** (0.021)	0.955*** (0.017)	0.867*** (0.018)	0.858*** (0.020)	0.783*** (0.026)
			Compensated fare elasticity		
Largest airline	-0.420*** (0.060)	0.339*** (0.045)	0.253*** (0.052)	0.170*** (0.057)	0.076 (0.065)
Second largest airline	0.214*** (0.028)	-0.754*** (0.040)	0.226*** (0.031)	0.260*** (0.038)	0.222*** (0.047)
Third largest airline	0.125*** (0.024)	0.174*** (0.023)	-0.731*** (0.031)	0.171*** (0.032)	0.171*** (0.040)
Fourth largest airline	0.061*** (0.020)	0.148*** (0.022)	0.126*** (0.025)	-0.762*** (0.038)	0.216*** (0.037)
Smallest airline	0.020 (0.017)	0.093*** (0.020)	0.094*** (0.023)	0.161*** (0.028)	-0.686*** (0.097)

Source: Author's calculations using Table 20 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B25. Leisure Travelers' Fare and Expenditure Elasticities for Medium Distance Trips: Markets with Five-and-More Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
Uncompensated fare elasticity					
Largest airline	-0.815***	-0.163	-0.062	-0.047	-0.206
	(0.131)	(0.110)	(0.125)	(0.141)	(0.693)
Second largest airline	-0.163***	-1.091***	0.114	0.368***	0.223
	(0.062)	(0.096)	(0.081)	(0.088)	(0.412)
Third largest airline	-0.097	0.060	-0.776***	-0.076	-0.027
	(0.051)	(0.058)	(0.089)	(0.075)	(0.330)
Fourth largest airline	-0.077	0.173***	-0.067	-1.043***	0.075
	(0.044)	(0.048)	(0.057)	(0.091)	(0.283)
Smallest airline	-0.105	0.069	-0.029	0.053	-0.754
	(0.169)	(0.174)	(0.195)	(0.221)	(0.916)
Expenditure elasticity	1.257***	0.952***	0.761***	0.745***	0.689
	(0.042)	(0.040)	(0.042)	(0.045)	(0.916)
Compensated fare elasticity					
Largest airline	-0.321***	0.211	0.237*	0.246	0.065
	(0.129)	(0.108)	(0.123)	(0.139)	(0.693)
Second largest airline	0.121**	-0.876***	0.286***	0.536***	0.379
	(0.062)	(0.096)	(0.081)	(0.088)	(0.412)
Third largest airline	0.107**	0.215***	-0.652***	0.045	0.085
	(0.051)	(0.058)	(0.090)	(0.075)	(0.330)
Fourth largest airline	0.077	0.290***	0.026	-0.951***	0.160
	(0.043)	(0.048)	(0.057)	(0.091)	(0.283)
Smallest airline	0.016	0.160	0.044	0.125	-0.688
	(0.169)	(0.174)	(0.195)	(0.221)	(0.916)

Source: Author's calculations using Table B10 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table B26. Leisure Travelers' Fare and Expenditure Elasticities for Long Distance Trips: Markets with Five-and-More Airlines

Airline	Largest airline	Second largest airline	Third largest airline	Fourth largest airline	Smallest airline
			Uncompensated fare elasticity		
Largest airline	-0.869***	0.031	-0.056	-0.173***	-0.219***
	(0.066)	(0.048)	(0.055)	(0.060)	(0.065)
Second largest airline	-0.026	-0.936***	-0.011	-0.022	-0.010
	(0.032)	(0.044)	(0.034)	(0.042)	(0.048)
Third largest airline	-0.069***	-0.014	-0.905***	0.043	0.057
	(0.028)	(0.026)	(0.040)	(0.036)	(0.042)
Fourth largest airline	-0.100***	-0.022	0.028	-0.820***	0.124***
	(0.023)	(0.024)	(0.028)	(0.044)	(0.038)
Smallest airline	-0.094***	-0.019	0.021	0.083***	-0.760***
	(0.015)	(0.021)	(0.025)	(0.028)	(0.106)
Expenditure elasticity	1.157***	0.960***	0.899***	0.889***	0.808***
	(0.023)	(0.019)	(0.020)	(0.022)	(0.140)
			Compensated fare elasticity		
Largest airline	-0.453***	0.376***	0.267***	0.147***	0.071
	(0.066)	(0.048)	(0.056)	(0.060)	(0.070)
Second largest airline	0.244***	-0.712***	0.199***	0.185***	0.178***
	(0.031)	(0.043)	(0.034)	(0.042)	(0.052)
Third largest airline	0.135***	0.154***	-0.747***	0.199***	0.199***
	(0.027)	(0.025)	(0.040)	(0.036)	(0.046)
Fourth largest airline	0.055***	0.106***	0.148***	-0.702***	0.232***
	(0.022)	(0.024)	(0.027)	(0.044)	(0.041)
Smallest airline	0.019	0.075***	0.109***	0.170***	-0.681***
	(0.019)	(0.022)	(0.025)	(0.030)	(0.027)

Source: Author's calculations using Table B11 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

APPENDIX C

EXPENDITURE AND FARE ELASTICITIES: BUSINESS TRAVELERS

Table C1. Business Travelers' Fare and Expenditure Elasticities for all Observation: Markets with Two Airlines

Airline	Largest airline	Smallest airline
Uncompensated fare elasticity		
Largest airline	-0.931*** (0.048)	-0.149*** (0.007)
Smallest airline	-0.334*** (0.001)	-0.704*** (0.078)
Expenditure elasticity	1.069*** (0.00003)	0.853*** (0.00003)
Compensated fare elasticity		
Largest airline	-0.202*** (0.034)	0.433*** (0.005)
Smallest airline	0.005*** (0.001)	-0.433*** (0.074)

Source: Author's calculations using Table 27 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

Table C2. Business Travelers' Fare and Expenditure Elasticities for all observation: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity			
Largest airline	-0.668***	-0.219***	-0.409***
	(0.109)	(0.097)	(0.121)
Second largest airline	-0.170***	-0.771***	0.004
	(0.005)	(0.096)	(0.218)
Smallest airline	-0.227***	-0.049	-0.370
	(0.105)	(1.046)	(0.332)
Expenditure elasticity	1.065***	1.039***	0.775***
	(0.331)	(0.028)	(0.033)
Compensated fare elasticity			
Largest airline	-0.173	0.264***	-0.049
	(0.106)	(0.094)	(0.251)
Second largest airline	0.194***	-0.416***	0.269
	(0.069)	(0.117)	(0.217)
Smallest airline	-0.020	0.153	-0.220**
	(0.105)	(0.123)	(0.106)

Source: Author's calculations using Table 28 and equations 9, 12 and 13
Standard errors are in parentheses
*=significant at 10% level, **=significant at 5% level, ***=significant at 1% level.

APPENDIX D

VARIABLES DESCRIPTION

Average Fare (p_{in}): The average one-way fare paid by every traveler with airline “i” at city pair “n”.

$$p_{in} = \left(\sum_{m}^{M} fare_{mn} * k_{mn} \Big/ \sum_{m}^{M} k_{mn} \right)$$

i : the airline, i=1,2,3,4,5

k : number of passengers paying the same fare, k=1,…, K

m : number of observations for the “n” city pair served by airline “i”, m=1,…,M

n: city pair, n=1,…., N

The Relative Fare (P_{in}) : The average fare paid to airline “i” divided by the average fare paid to the smallest airline in the same city pair and same market.

$$P_{in} = \log\left(\frac{p_{in}}{p_{lowestn}} \right)$$

Airline Revenue at Specific City Pair: The total expenditure by travelers using the services of that specific airline at specific city pair.

$$E_{in} = \sum_{m} k_m * fare_m$$

I : the airline, I==1,2,3,4,5

k : number of passengers paying the same fare, k=1,…, K

m : number of observations for the "n" city pair served by airline "i",

m=1,…,M

n: city pair, n=1,…., N

Total Expenditure on Air Travel at a City Cair: The sum of total expenditure on air travel on each airline at that specific city pair;

$$E_n = \sum_{i=1}^{I} E_{in}$$

i : the airline, i=1,2,3,4,5

n: city pair, n=1,…., N

The Airline Share: Airline revenue at a given city pair divided by the total expenditure on air travel at that city pair.

$s_{in} = \left(\frac{E_{in}}{E_n}\right)$, and the sum is equal to one for each city pair.

i : the airline, i=1,2,3,4,5

n: city pair, n=1,…., N

Stone Fare index: The Fare index of air travel at a given city pair weighted by airline shares.

$$\log(P_n) = \sum_{i=1}^{J} s_{in} \log(p_{in})$$

i : the airline, i=1,2,3,4,5

n: city pair, n=1,…., N

APPENDIX E

ESTIMATION OF THE DELETED EQUATION PARAMETERS

From the specification of the model, the parameters are calculated as the following:

$\hat{\gamma}_{ilowest} = 0 - \hat{\gamma}_{i1} - \hat{\gamma}_{i2}$ where i is the largest or second largest airline

$\hat{\beta}_{lowest} = 0 - \hat{\beta}_1 - \hat{\beta}_2$ where 1 refers to largest and to second largest airlines

$\hat{\alpha}_{lowest} = 1 - \hat{\alpha}_1 - \hat{\alpha}_2$

The variances of the parameters can be calculated by using the delta method as following:

$$\text{var}(\gamma_{ilowest}) = \left[\frac{\partial \gamma_{ilowest}}{\partial \hat{\gamma}_{i1}}\right]^2 \bullet \text{var}(\hat{\gamma}_{i1}) + \left[\frac{\partial \gamma_{ilowest}}{\partial \hat{\gamma}_{i2}}\right]^2 \bullet \text{var}(\hat{s}_1) + \left[\frac{\partial \hat{\theta}^s}{\partial \hat{s}_2}\right]^2$$

$$\bullet \text{ var}(\hat{s}_2) + 2\left[\frac{\partial \hat{\gamma}_{ilowest}}{\partial \hat{\gamma}_{i1}}\right] \bullet \left[\frac{\partial \hat{\gamma}_{ilowest}}{\partial \hat{\gamma}_{i2}}\right] \bullet \text{cov}\left(\hat{\gamma}_{i1}, \hat{\gamma}_{i2}\right)$$

and same way for the other parameters.

APPENDIX F

AIRLINES' NAMES

Table C1. List of Airlines Used in the Dissertation

Airline Name	Group	DOT Code
American Airlines, Inc.	Major	AA
Alaska Airlines, Inc.	Major	AS
Continental Air Lines, Inc.	Major	CO
Delta Air Lines, Inc.	Major	DL
America West Airlines, Inc.	Major	HP
American Eagle Airlines,inc	Major	MQ
Northwest Airlines, Inc.	Major	NW
American Trans Air, Inc.	Major	TZ
United Air Lines, Inc.	Major	UA
US Airways, Inc.	Major	US
Southwest Airlines, Co.	Major	WN
Discovery Airways, Inc.	National	DH
Atlantic Southeast Airlines	National	EV
Comair, Inc.	National	OH
Executive Airlines	National	OW
Expressjet Airlines, Inc.	National	RU
Air Wisconsin Airlines Corp	National	ZW
Chautauqua Airlines, Inc	National	RP
Skywest Airlines, Inc.	National	OO
Continental Micronesia	Regional	CS
Air Midwest, Inc.	Regional	ZV

APPENDIX G

HOMOGENEITY AND SYMMETRY RESTRICTIONS TESTS

Table G1. Homogeneity and Symmetry Restrictions: Likelihood Ratio Test Results

	Homogeneity and Symmetry	Homogeneity	Symmetry	Homogeneity single equation test [a]
Markets with two airlines		14.93 (0.001)		0 accept 1 reject
Markets with three airlines	9.81 (0.020)	1.45 (0.485)	8.82 (0.003)	2 accept 0 reject
Markets with four airlines	16.22 (0.012)	9.84 (0.020)	4.37 (0.220)	1 accept 2 reject
Markets with five-and-more airlines	26.14 (0.003)	15.33 (0.004)	9.76 (0.135)	3 accept 1 reject

Probabilities are in parentheses

A: shows number of equations the homogeneity restriction was accepted or rejected.

APPENDIX H

CROSS AND OWN-FARE ELASTICITY: COMPARISON

Table H1. Uncompensated Cross & Own-Fare Elasticities Using Capps Jr. et al. (2003) Formulas: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity: leisure travelers			
Largest airline	-0.871	-0.148	-0.079
Second largest airline	-0.130	-0.801	0.104
Smallest airline	-0.122	0.044	-0.728
Uncompensated fare elasticity: business travelers			
Largest airline	-0.680	-0.222	-0.380
Second largest airline	-0.164	-0.776	0.057
Smallest airline	-0.237	-0.046	-0.316
Uncompensated fare elasticity: all observations			
Largest airline	-0.896	-0.107	-0.068
Second largest airline	-0.110	-0.818	0.067
Smallest airline	-0.117	0.022	-0.704

Source: Author calculations using equations 10 and 11

Table H2. Differences in Calculated Uncompensated Cross & Own-Fare Elasticities Using Capps Jr. et al. (2003) and Common Formulas: Markets with Three Airlines

Airline	Largest airline	Second largest airline	Smallest airline
Uncompensated fare elasticity: leisure travelers			
Largest airline	0.007	0.002	0.106
Second largest airline	-0.006	-0.006	0.000
Smallest airline	-0.018	-0.001	-0.020
Uncompensated fare elasticity: business travelers			
Largest airline	-0.011	-0.003	0.030
Second largest airline	0.006	-0.005	0.053
Smallest airline	-0.010	0.003	0.054
Uncompensated fare elasticity: all observations			
Largest airline	0.006	0.000	0.104
Second largest airline	-0.004	-0.005	0.002
Smallest airline	-0.018	0.000	-0.021

Source: Author calculations from Tables A16, B16, C2 and H1.

VITA

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