Market Competition, Price Dispersion and Price Discrimination in the U.S. Airlines Industry

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Abstract

This paper examines price dispersion and price discrimination in airline fares across different domestic routes. It studies whether industry competition - market concentration and market share - affects ticket price dispersion and price discrimination. The analysis shows that price dispersion in fares across routes is negatively correlated with market concentration, but positively correlated with market share. The presence of airlines with relatively small market shares within a route that is dominated by a major airline leads to negative correlations between price dispersion and market shares. However, price discrimination only increases for certain ticket restrictions as competition decreases, where the presence of low cost carriers may be a contributing factor.

1. Introduction/Literature Review

This paper examines airline ticket price dispersion and price discrimination across different domestic routes. It studies whether industry competition - market concentration and market share - affects ticket price dispersion and price discrimination. The analysis shows that price dispersion in fares is negatively correlated with market concentration, but positively correlated with market share. The presence of airlines with relatively small market shares within a route that is dominated by a major airline leads to negative correlations between price dispersion and market shares. I find evidence that price discrimination increases with competition for only certain ticket restrictions, where the presence of low cost carriers may be a contributing factor.

Major changes have occurred in the U.S. airline industry since the implementation of the Airline Deregulation Act in 1978. As the federal Civil Aeronautics Board (CAB) removed its grip on fares, routes and market entry regulation in the airline industry, there has been unprecedented growth within the industry, especially in terms of productivity (Kahn, 1993). Lower fares have also been reported after deregulation and the flexibility of the industry yielded higher dispersion in fares. Lower market barriers encouraged airlines to increase the number of service routes, thus providing consumers with more options to choose from (Kahn, 1993). As a result, there exist wide variation in airline ticket price across routes.

According to Borenstein and Rose (1994), airline ticket price dispersion increases on highly competitive routes and low operating flight density routes, which is "consistent with discrimination based on customer's willingness to switch to alternative airlines or flights." On the other hand, Gerardi and Shapiro (2009) conclude differently. They find that price dispersion decreases with competition, especially for routes with consumers of relatively homogenous elasticity. This observation is consistent with the textbook version of price discrimination theory. It is no surprise that the authors come to different conclusions, since they used different empirical methods and analytical datasets: Borenstein and Rose (1994) use a cross-sectional dataset from 1986, whereas Gerardi and Shapiro (2009) use a panel dataset from 1993 to 2006. Gerardi and Shapiro (2009) cite the emergence of low cost carriers and exploitation of changes in competition over time as possible reasons behind the difference in estimates.

Several airline mergers and bankruptcies took place after the deregulation of the airline industry. As a result, the overall industry became more concentrated. However, Kahn (1993) suggests that concentration in individual routes is more important than concentration in the national level, as travelers only consider choices given a specific route. The combination of higher and lower market concentration at the national level and in individual routes respectively resulted in a two-tiered market condition. This complex market structure contributes to an increase of price discrimination practices among airlines, as airlines are no longer restricted by direct price regulations (Kahn, 1993).

Basic economic intuition suggests that price discrimination increases with market concentration. However, several literatures seem to conclude otherwise. An empirical study by Stavins (1996) finds that price discrimination decreases with market concentration within the airline industry (price discrimination is higher on routes with more competition). The Stavins (1996) study is supported by similar theoretical findings in Borenstein (1985) and Holmes (1989).

The aforementioned studies provide a framework in which the patterns of market competition, ticket price dispersion and price discrimination can be further explored. This paper examines airline prices in two major parts. First, I analyze a government dataset from the second quarter of 2013 in order to understand price dispersion in the airline industry for the most recent time period. I also examine the recent relationship between competition and price dispersion using price discrimination theories. In the second section, I use a transaction dataset from the fourth quarter of 2004 to investigate whether price discrimination increases or decreases as market competition increases.

The paper is structured as follows. Section 2 explores the economic motivation behind the airline pricing system, while Section 3 explains the empirical methodology. Section 4 describes the dataset. Section 5 elaborates on the descriptive statistics and Section 6 discusses the results. Last but not least, Section 7 concludes.

2. Motivation

According to Stigler (1987), price discrimination is defined as the practice of having two or more similar commodities sold at prices that are in different ratios to marginal costs. Economic theory suggests that not all firms can price discriminate, one example being firms in perfectly competitive markets. In order for firms to price discriminate successfully, it is important that there exist a heterogeneous group of consumers with varying degrees of willingness-to-pay so that the market can be segmented. Furthermore, the possession of some market power is necessary for firms to charge prices higher than the marginal cost. Low chances for consumers to arbitrage price differences also influence a firm's ability to price discriminate.

Airline ticket pricing is an excellent example of price discrimination. Consumers of airline tickets have different willingness-to-pay and demand elasticities. Although airlines are unable to charge each consumer differently (as they have no knowledge of the individual's willingness-to-pay), they are able to segment the market based on different demand elasticities using self-sorting mechanisms such as Saturday night stay and non-refundable tickets.

Price dispersion can arise from price discrimination and cost variation. Borenstein and Rose (1994) explain the correlation between price discrimination and price dispersion, using factors such as market structure, population characteristics, and product attributes; as well as cost variation within the market. In the first section of this study, I focus on the correlation between price dispersion and price discrimination based on competition between firms. Monopolistic firms are more likely to price discriminate than oligopolistic firms; therefore, I expect a decrease in price dispersion as the level of competition increases, holding all else constant.

Additionally, Stavins (1996) states that price discrimination could increase or decrease with competition: price discrimination decreases as carriers lower their overall ticket prices. Price discrimination increases with competition when carriers segment their market based on demand elasticities of tourists and business travelers: carriers charge tourists at marginal costs and business travelers at higher markups. The second section of this study focuses on the relationship between market concentration and price discrimination. Following the Borenstein and Rose (1994) findings, I postulate that price discrimination decreases with market concentration, as it is likely that price discrimination and price dispersion are positively correlated.

3. Methodology

3.1 Market Competition and Price Dispersion

Price dispersion is likely to differ across routes and airlines. Airline competitiveness also varies for different market routes. Therefore, in this paper, I aim to investigate the following questions:

1. What is the magnitude of price dispersion across different markets with the same airport origin and how is it distributed?

2. How is price dispersion correlated with market share and market concentration respectively *across* routes? Also, how is price dispersion correlated with market share *within* each route?

According to Borenstein and Rose (1994), price dispersion is essentially characterized by the inequality across the entire range of fares paid by customers, and can be measured by the Gini coefficient. The Gini coefficient captures the magnitude of price dispersion by providing the expected relative difference in fares as a ratio to the mean fare for a randomly drawn customer from a population. A Gini coefficient of zero implies perfect equality and a Gini coefficient of one suggests perfect inequality. Therefore, a low Gini coefficient indicates small dispersion of fares, whereas a high Gini coefficient implies large dispersion of fares.

In order to examine how price dispersion is correlated with market share and market concentration, I use the population correlation coefficient to measure the level of dependence between the variables. I calculate the correlation coefficient between market share and price dispersion (measured by the Gini coefficient) using the formula

$$\rho_{MarketShare,\,Gini} = \frac{\operatorname{cov}(MarketShare, Gini)}{\sigma_{MarketShare}\sigma_{Gini}}$$

where

$$\operatorname{cov}(MarketShare, Gini) = E[(MarketShare - \mu_{MarketShare})(Gini - \mu_{Gini})]$$

assuming that market share has mean $\mu_{MarketShare}$ and standard deviation $\sigma_{MarketShare}$ and Gini has mean μ_{Gini} and standard deviation σ_{Gini}.

Similarly, the correlation between market concentration and price dispersion is calculated by

$$\rho_{MarketConcentration,Gini} = \frac{\operatorname{cov}(MarketConcentration, Gini)}{\sigma_{MarketConcentration}\sigma_{Gini}}$$

where

$$\operatorname{cov}(MarketConcentration, Gini) = E[(MarketConcentration - \mu_{MarketConcentration})(Gini - \mu_{Gini})]$$

assuming that market concentration has mean $\mu_{MarketConcentration}$ and standard deviation $\sigma_{MarketConcentration}$ and Gini has mean μ_{Gini} and standard deviation σ_{Gini}.

Although monopoly models suggest that *price discrimination* increases as market share increases, Borenstein (1985) and Holmes (1989) argue that competitive based price discrimination may result in a negative correlation between price dispersion and market share. Carriers with large market shares in competitive type markets may be less responsive to cross-price elasticities in terms of price setting (Borenstein and Rose, 1994). Similarly, increases in market concentration may lead to increases or decreases in *price discrimination*, depending on the market structure. Therefore, I can expect either a positive or negative correlation coefficient between *price discrimination* and market share or market concentration. Since cost variations and other factors influencing *price discrimination* such as population characteristics cannot be accounted for in the population correlation model, the sign of the correlation coefficient of *price dispersion* and market share or market concentration is unknown.

3.2 Market Competition and Price Discrimination

Various literatures conclude that price discrimination decreases with market concentration. In this paper, I aim to test whether this hypothesis still holds in a more recent timeline. I apply Stavins' (1996) methods to estimate the effect of market competition on price discrimination: I first estimate a restricted model, where price discrimination is assumed not to vary with market concentration; and then a restricted model, where price discrimination is assumed to vary with market concentration.

3.2.1 Restricted Model

The regression equation for the restricted model is as follows:

$$P_{ijk} = \beta_0 + \beta_1 R_{ijk} + \beta_2 HHI_i + \beta_3 MS_{ij} + \beta_4 Dist_i + \beta_5 DistSq_i + \beta_6 AvgPop_i + \beta_7 AvgInc_i + \beta_8 Hub_{ij} + \beta_9 Slots_i + \beta_{10} OneWay_{ijk} + \beta_{11} TicketClass_{ijk} + \beta_{12} Days_{ijk} + \beta_{13} LCC_i + \beta_{14} SW_i + \beta_{15} Tourist + \varepsilon_{ijk}$$

where *P* is the round-trip fare; *R* refers to ticket restrictions (advanced purchase, non-refundable, Saturday stay-over, travel days restriction, minimum and maximum stay requirement); *HHI* is the route specific Herfindahl-Hirschman Index; *MS* is the carrier specific market share calculated based on the share of passengers travelling on an airline within a route; *Dist* and *DistSq* are the distance and distance squared of a particular route; *AvgPop* and *AvgInc* represent the average population and average per-capita income of the two corresponding airport cities respectively; *Hub* is an indicator variable that equals 1 if the carrier has a hub in either the origin or destination airport; *Slots* is an indicator variable that equals 1 if the endpoint airports regulate the number of landing slots; *OneWay* is an indicator variable that equals 1 if the itinerary entails a one-way trip, *TicketClass* equals to 1 if any segment of itinerary involved travel in full coach fare class and *Days* refers to the number of days prior to departure when the ticket was purchased. The two additional variables which I included in the model (but are not included in Stavins' (1996) model) are *LCC* and *SW*, which are indicator variables that equals 1 if low cost carriers and Southwest airlines are operating within the route respectively. Also, instead of using regional temperature as a proxy for tourist measure, the actual tourist share is used, denoted by *Tourist*. Subscript *i* refers to a market route, *j* refers to a carrier and *k* refers to an single itinerary.

3.2.2 Unrestricted Model

The regression equation for the unrestricted model is as follows:

$$P_{ijk} = \beta_0 + R_{ijk}(\gamma_0 + \gamma_1 HHI_i + \gamma_2 MS_{ij}) + \beta_1 HHI_i + \beta_2 MS_{ij} + \beta_3 Dist_i + \beta_4 DistSq_i + \beta_5 AvgPop_i + \beta_6 AvgInc_i + \beta_7 Hub_{ij} + \beta_8 Slots_i + \beta_9 OneWay_{ijk} + \beta_{10} TicketClass_{ijk} + \beta_{11} Days_{ijk} + \beta_{12} LCC_i + \beta_{13} SW_i + \beta_{15} Tourist + \varepsilon_{ijk}$$

where the variables are defined in a similar fashion as described in Section 3.2.1. The interaction terms allows the effect of price discrimination to vary with market concentration, thus yielding

$$\frac{\partial P_{ijk}}{\partial R_{ijk}} = \gamma_0 + \gamma_1 HHI_i + \gamma_2 MS_{ij}$$

where γ_1 and γ_2 refer to the effect of market concentration and market share on price discrimination, respectively.

4. Data

4.1 Market Competition and Price Dispersion

The data used in the first section of this study is constructed using information obtained from Databank 1B (DB1B) of the United States Department of Transportation. It contains ticket itinerary and price details of a 10% random sample of all U.S. domestic airline tickets. Each observation in the dataset consists of a pair of origin and destination airports, total distance travelled, round-trip indicators, operating carrier and fare levels (round-trip or one-way) as well as the number of passengers travelling on a particular fare.

One-way fares are used in the analysis for simplicity purposes; with reported fares of round-trip itineraries halved. I classify the top 10% of fares as first-class or business class tickets and they are excluded due to the difficulty of addressing variations in costs across different types of tickets (Borenstein and Rose, 1994). Furthermore, I exclude observations with reported fares of $10 and less, since they are most likely frequent-flyer redemption trips. The analysis is also restricted to carrier-routes in which fare information is available for at least 10 customers. Due to time constraints, I narrow observations to flights from Detroit Metropolitan Wayne County Airport (DTW) to the following nine destinations:

Destination Airport	Airport Code
Boston Logan International Airport	BOS
Denver International Airport	DEN
Dallas/Fort Worth International Airport	DFW
Los Angeles International Airport	LAX
Las Vegas McCarran International Airport	LAS
New York City LaGuardia Airport	LGA
Phoenix Sky Harbor International Airport	PHX
Seattle-Tacoma International Airport	SEA
San Francisco International Airport	SFO

Table 1: Choice of Destination Airports

This results in a total of 4939 observations

The price dispersion is measured by a Gini coefficient computed using one-half the ratio of the mean difference to the mean. In the context of this paper, I follow Borenstein and Rose's (1994) definition of a market: a route consisting of a pair of origin and destination airports. For instance, flights from DTW to BOS are considered in one market, and flights from DTW to LGA are in another. Next, I characterize competition by market share and market concentration. Market share of each carrier is equal to the ratio of the number of customers flying on a particular carrier-route to the total number of customers flying on that particular route. For example, the market share of American Airlines in the DTW - BOS airport-pair market is calculated as the ratio of number customers flying in American Airlines from DTW to BOS to the total number of customers flying from DTW to BOS. The Herfindahl-Hirschman Index (HHI), which measures market concentration, for each airport-pair market is equal to the sum of squares of market share held by each carrier operating within the market.

4.2 Market Competition and Price Discrimination

The dataset used in the second section of this study is obtained from Sengupta and Wiggins (2014) via the American Economic Journal (AEJ). According to the authors, the final dataset is assembled using different data sources: contemporaneous transaction data purchased from a major computer reservation system (CRS), ticket restriction information obtained from travel agent systems, T-100 Segment data accessed via the U.S. Department of Transportation, business share index derived by Borenstein (2010), and the U.S. Census for the year 2003. The transaction period falls on the fourth quarter of year 2004, which includes peak travel period such as Thanksgiving, Christmas and New Years. To avoid estimation biases, Sengupta and Wiggins (2014) excluded itineraries on Thanksgiving week and after December 22, 2004. They also collected ticket restriction information from a local travel agent, as the CRS company was unable to provide the relevant information due to confidentiality. A subset of itinerary information (the remaining data was randomly erased due to the time difference in the actual data collection process) was matched with the transaction data to obtain restrictions on the individual tickets. Sengupta and Wiggins (2014) also applied a matching rule to overcome the limitations of the subset of travel agent data: if two prices from the dataset match within 2%, it is considered as a match if other ticket characteristics such as carrier, booking class, and restrictions are the same. They also followed Borenstein and Rose (1994) method of excluding first and business class itineraries. The dataset also only includes direct travel itineraries, as the number of itineraries with a stopover is small (approximately 2%).

Each observation in the dataset consists of information on a single itinerary: pair of origin and destination airport[1], operating carrier, one-way travel indicators, ticket class, number of days prior to departure after ticket purchase, restrictions, market competition measures, population and airport attributes of the route. The ticket restrictions are advanced purchase requirement, non-refundable, Saturday night stay-over, travel days restrictions, minimum and maximum stay requirement.

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[1] The list of endpoint airports and cities included in Sengupta and Wiggins (2014) study can be accessed through https://www.aeaweb.org/aej/pol/app/0601/2009-0200_app.pdf

In addition, the market competition measures included are market share and concentration. Market share is the share of passengers travelling on a particular airline within a route calculated based on the T-100 Segment dataset. The Herfindahl-Hirschman Index (HHI), which measures market concentration, is calculated as the sum of squares of a carrier's market share within a route.

On the other hand, the population and airport attributes are characterized by distance between origin and destination airports, tourist share (calculated using a business share index derived by Borenstein (2010), average population, average per capita income of the two endpoints of the route (obtained from the U.S. Census 2003), airport hub indicators (if the origin or the destination airport is a hub) and slot restricted airports indicators (if an airport has restricted slots). A list of routes included in the study can be found in the Appendix section.

5. Descriptive Statistics

5.1 Market Competition and Price Dispersion

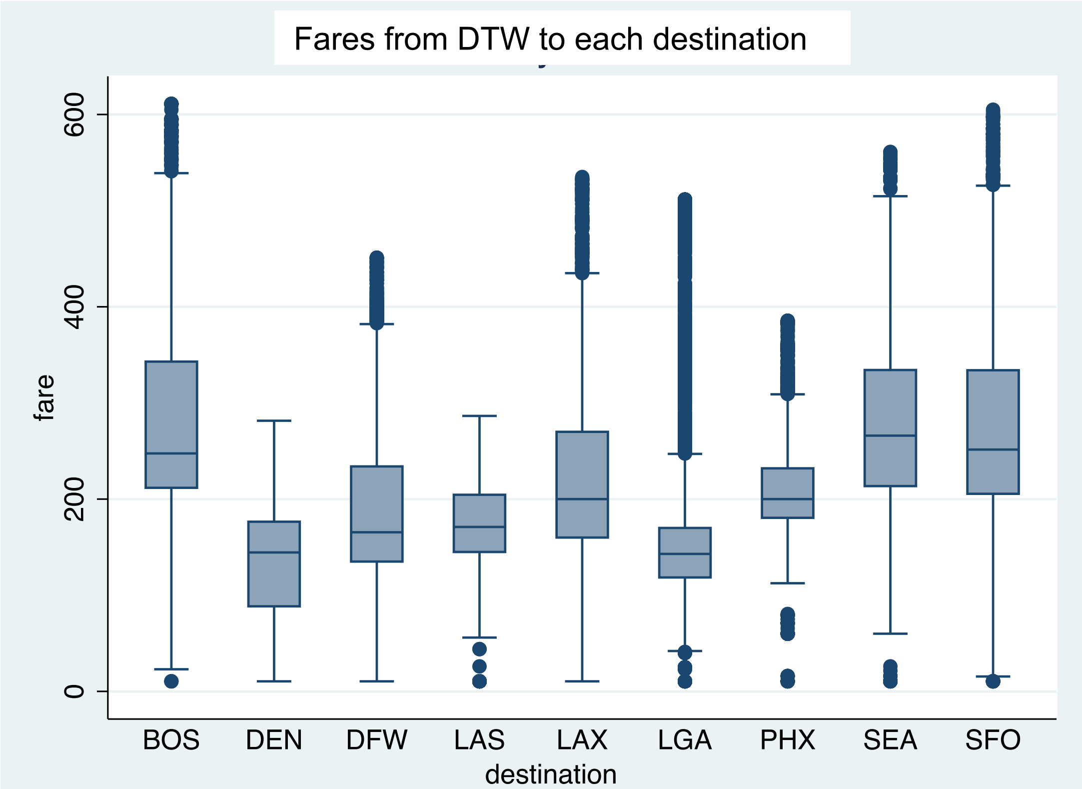
This section presents some descriptive statistics and graphical analysis of airline ticket fares. I use boxplots to illustrate the entire range of consumer-paid fares within each market route and highlight the variation of fares for routes and airlines. The tables and figures show that fare range patterns vary for different airport-pair market routes and different airlines within a route.

Destination	Mean	Standard Deviation	N[2]	Min	Max	25th percentile	50th percentile	75th percentile	Skewness
BOS	282.0	124.6	1516	10.5	611.0	211.8	247.5	343.0	0.889
DEN	140.2	62.8	6044	10.5	281.5	88.5	144.5	176.5	0.065
DFW	195.6	97.8	2693	10.5	451.0	135.0	165.5	234.0	1.024
LAS	174.6	46.6	7672	10.5	286.5	145.0	171.0	204.5	0.024
LAX	229.7	100.1	3686	10.5	534.0	160.0	200.0	270.0	1.037
LGA	164.5	94.3	9798	10.5	511.5	118.5	143.0	170.0	2.074

[2] Total number of customers

PHX	214.1	61.39	2717	10.5	385.5	180.5	200.0	232.0	0.639
SEA	279.5	105.2	1188	10.5	561.0	213.5	266.0	334.3	0.304
SFO	281.1	115.5	2101	10.5	605.0	205.5	251.5	334.0	0.770

Table 2: Descriptive statistics of fares from DTW to different airport destinations



To read the boxplots: the line within the box represents the median (50th percentile); the top and bottom edge of the box represents the 75th percentile and the 25th percentile; and the top and bottom edge of the line represents the maximum and minimum of values, which excludes outliers; the dots (which may look like lines in bold) represents the outliers of the data

Source: Databank DB1B from Department of Transportation

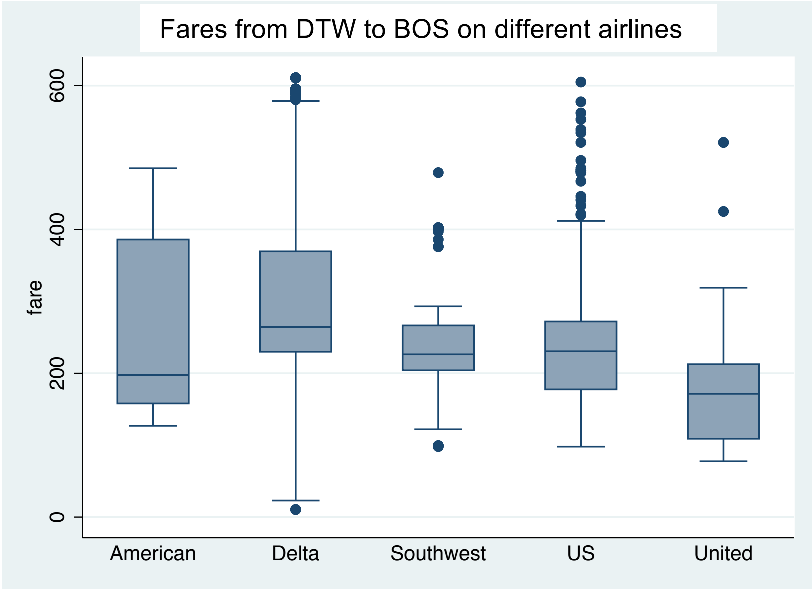
Figure 1: Boxplot of Fares from DTW to each destination

Based on Figure 1 and Table 2, fares to BOS, SEA and SFO have high ranges, interquartile ranges and standard deviations. This observation implies large variation in fares to BOS, SEA and SFO. Conversely, fare variation is small for flights to DEN, LAS and PHX, as the fares have low ranges and standard deviations. In addition, fares to LGA, LAS and PHX have low interquartile ranges, which suggest consistent pricing (around the mean) for these routes. The converse applies to the BOS, SEA and SFO market route. Positive skewnesses of fares across all destinations show that airlines price more of their fares higher than the mean. Fares to DEN and LAS have the lowest skewness, whereas fares to LGA and LAX have the highest skewness. It is likely that airlines operating in DTW - DEN and DTW - LAS price their fare nearer to the mean than airlines in other markets, and vice versa for airlines operating in DTW - LAX and DTW – LGA.

Table 2 shows that flights to DEN, LGA and LAS have large customer bases. These routes also have relatively low mean and median fares. In contrast, flights with small customer bases, such as BOS, SEA and SFO, have relatively high means and medians. Fare levels are implicitly influenced by the demand curves of customers who fly to these destinations and competition from low cost carriers. Business travelers may travel more often to Boston, Seattle and San Francisco for conferences, thus increasing the mean and median fares associated with these routes. On the other hand, tourists may choose to travel to cheaper destinations based on their demand elasticities. The significant presence of low-cost carriers such as Spirit and Frontier in routes to Denver, New York and Las Vegas allows customers with high demand elasticities to travel. The mean and median of fares to these three destinations are lower than others, as tickets sold by low-cost carriers are cheaper compared to non-low-cost carriers.

Airline	Mean	Standard Deviation	N	Min	Max	25th percentile	50th percentile	75th percentile	Skewness
American	254.1	118.4	14	127.0	485.0	158.0	197.5	386.0	0.649
Delta	308.5	133.2	986	10.5	611.0	230.0	264.5	369.5	0.607
United	182.4	98.8	53	77.5	521.0	109.0	171.5	212.5	1.744
US	237.7	84.1	382	98.0	605.0	177.5	230.5	272.0	1.475
Southwest	237.6	80.3	80	98.0	479.0	204.0	226.3	266.5	0.836

Table 3: Descriptive statistics of fares from DTW to BOS on different airlines



To read the boxplots: the line within the box represents the median (50th percentile); the top and bottom edge of the box represents the 75th percentile and the 25th percentile; and the top and bottom edge of the line represents the maximum and minimum of values, which excludes outliers; the dots represents the outliers of the data
Source: Databank DB1B from Department of Transportation

Figure 2: Boxplot of fares from DTW to BOS on different airlines

According to Table 3 and Figure 2, Delta has the highest range and standard deviation of fares, whereas Southwest has the lowest range and standard deviation of fares. This suggests that Delta and Southwest have the largest and smallest variation in fares within the DTW – BOS market respectively. The large interquartile fare range of American suggests non-consistency in fare pricing about mean, and the opposite applies to Southwest. The small customer base of American combined with its practice of charging low prices on most of its customers and high price on others (yield management practices) explain the large interquartile range and low median I find for American. Table 3 also shows that Delta has the largest number of customers, and the highest mean and median fare. Delta's large market share within the route allows it to price its fares higher than its competitors.

Similar explanations apply to the tables and boxplots of fares from DTW to the remaining eight destinations listed in Table 1, although the context may be different for each airline. The corresponding figures and tables can be found in the Appendix.

5.2 Market Competition and Price Discrimination

The descriptive statistics and correlation tables for the second dataset can be found in the Appendix section[3].

6. Results

6.1 Market Concentration and Price Dispersion

In this section, I discuss the relationship between price dispersion and market share as well as market concentration. I first present a summary of price dispersion and market concentration for different airport-pair markets, followed by a description of price dispersion and market shares of different carriers for each destination airport subgroup.

Destination	Gini coefficient	Herfindahl
BOS	0.2372	.4912481
DEN	0.2549	.2839061
DFW	0.2640	.3445098
LAS	0.1495	.3623434
LAX	0.2331	.3755926
LGA	0.2677	.3420193
PHX	0.1509	.379772
SEA	0.2082	.5074808
SFO	0.2233	.5886304

Table 4: Gini coefficients of fares and HHI of different airport-pair markets

According to Table 4, fares to LGA have the greatest dispersion, with an expected price difference[4] of 53.54% from the mean fare. On the other hand, fares to LAS have the smallest dispersion, with an expected price difference of 29.9% from the mean fare.

The Herfindahl-Hirschman Index (HHI) - a measure of market concentration - is the highest for DTW – SFO airport-pair market, thus implying a lack of competition within the route. This is reflected by Delta's huge market share of 75.68%, with each of the remaining

[3] Refer to Table 18
[4] Expected price difference = 2 × Gini coefficient

carriers owning less than 10% of the DTW – SFO market[5]. Conversely, the DTW – DEN airport-pair market exhibits the lowest Herfindahl-Hirschman Index, which suggests that competition is moderate within the market, as implied by Spirit and Delta's relatively equal market share of 33.32% and 37.59%[6].

The correlation coefficient between market concentration and price dispersion is reported to be -0.1340, and this indicates that price dispersion is negatively correlated with market concentration. Although monopolistic price discrimination theory postulates that price dispersion and market concentration are positively correlated, the negative correlation that I find in the data comes from the specific competitive type market structure within the routes. Borenstein and Rose (1994) also find this negative correlation in their data. In the competitive type market structure, carriers compete on different segments of cross-price elasticities (Borenstein, 1985 and Holmes, 1989). Carriers are forced to lower their fares for consumers with high demand elasticities (tourists) as competition increases; but are still able to maintain fares for consumers with low demand elasticities (business travelers) based on its unique market niche. This results in an increase of price discrimination.

Additional analysis shows that market share and Gini coefficient are positively correlated, with a correlation coefficient of 0.1922. Although this corresponds with the expected sign postulated by monopolistic price discrimination theory, the competitive type market theory developed by Borenstein (1985) and Holmes (1989) – which results in a negative correlation sign – is more relevant in this case. The difference in correlation signs can be explained by a high magnitude spillover effect due to origin and destination airport dominance by certain airlines[7]. However, airport dominance does not imply a lack of

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[5] refer Figure 19 in Appendix
[6] refer Figure 12 in Appendix
[7] refer Table 6

competition within the routes. The formation of airline hubs, which results in airport dominance, allows airlines to transport their customers efficiently and maximize revenues.

There are two possible explanations for the positive correlation coefficient between price dispersion and market share: origin airport dominance by Delta, or destination airport dominance by other airlines. None of the airlines has a hub in Detroit Metropolitan Wayne Country Airport (DTW) except for Delta Airlines, as indicated by its market share. According to Figures 11 – 19 in the Appendix, Delta accounts for a minimum market share of 37.59% of total customers flying to DEN and a maximum market share of 75.68% of total customers flying to SFO. Delta's huge market shares also implies that customers who fly often from DTW are more likely to own a Delta frequent flyer plan than another airline's frequent flyer plan. Borenstein and Rose (1994) postulate that frequent flyer plans can result in a reduction of cross-elasticities through increments in ticket value or incentives. Therefore, customer participation in Delta's frequent flyer plans may result in an increase of price discrimination, as these customers are less responsive to fare increments compared to the regular customer base. The same argument applies to airlines that dominate other destinations.

Destination	Correlation Coefficient
BOS	-0.1311
DEN	0.5769
DFW	0.5084
LAS	0.3541
LAX	0.3733
LGA	0.2075
PHX	0.1591
SEA	-0.2451
SFO	0.3682

Table 5: Correlation coefficients of market share and Gini coefficent for each destination

Based on the destination-subgroup analysis on price dispersion and market share (presented in Table 5), I find positive correlation coefficients for flights to all destination airports except for BOS and SEA. Delta has several hubs across the U.S. other than its major hub in DTW, four of which are destination airports included in the analysis of this paper: BOS, LAX, LGA and SEA. Two out of four of Delta's hubs report negative correlation coefficients between market share and price dispersion. Further research on airport hubs[8] shows that destination airports that only Delta uses as a hub (BOS and SEA) are the ones that reported the negative correlation coefficients. Conversely, destinations that act as hubs or focus cities for multiple U.S. domestic airlines (including Delta), report positive correlation coefficients.

The negative correlation coefficient of market share and Gini coefficient of fares within the DTW - BOS and DTW - SEA market indicates that as market share increases, price dispersion decreases. Figure 2 and Figure 9 show that Delta possesses the highest range of fares within the markets. Furthermore, Delta has over 60% of market share in these two routes[9], and is the sole domestic airline that uses these two destination airports as hubs. The negative correlation between price dispersion and market share for flights to BOS is due to the presence of US Airways, which has a small market share but high price dispersion[10], within the market. Likewise, Figure 9 provides a similar explanation for the negative correlation between price dispersion and market share for flights to SEA. The figure shows that all airlines that operate from DTW to SEA show high price dispersion even though all airlines except Delta have low market shares[11]. Therefore, the presence of airlines with low market shares in a route that is dominated by another airline does not prevent other airlines from offering a variety of ticket prices to consumers. On the other hand, the positive correlation coefficient that I find for the remaining subgroups can be explained using the argument presented in the previous paragraph regarding destination airport dominance by airlines, which induces customer participation in frequent flyer plans.

[8] refer Table 6
[9] refer Figure 11 and Figure 18 in Appendix
[10] refer Figure 2 and Figure 11 in Appendix
[11] refer Figure 18 in Appendix

Airline	Hubs / Focus Cities[12] (destinations included in the analysis)
American	DFW, LAX
Delta	BOS, LAX, LGA, SEA
Frontier	-
AirTran	-
Spirit	DFW, LAS
United	DEN, LAX, SFO
US	PHX
Southwest	DEN, LAX, LAS, PHX

Table 6: Hubs / Focus cities for different airlines

6.2 Market Concentration and Price Discrimination

The regression equation for the restricted and unrestricted model is estimated using the ordinary least squares (OLS) method. Carrier fixed effects are used to control for carrier specific characteristics.

6.2.1 Restricted Model

According to Table 7, including a 1, 5, 7, 10, 14 and 21-day advance purchase restriction leads to, on average, a decrease within the range of $44 to $192 in round-trip fares. On the other hand, including a 3-day and 30-day advance purchase restriction leads to, on average, an increase of $54 and $27 in round-trip fares respectively. The coefficients on all types advance purchase restrictions are significant at the 1% level except for the 3-day and 30-day restriction. Intuition generally suggest that those who purchase tickets earlier would pay a lower price than those who purchase it later, assuming that they are travelling within the same flight. In this case, we would expect to see a monotonic decrease in price as the number of days of advance purchase requirement increases, holding all else constant. However, the corresponding coefficients on advance purchase restriction indicate a relatively

[12] Focus cities: a city that does not act as a hub for a specific airline, but behaves like a hub.

irregular pattern. One reason behind this observation is that airlines employ yield management practices in order to maximize their revenue, where they make use of shifts in market demand.

In addition, a non-refundable restriction leads to, on average, a $198 decrease in round-trip fares, and the coefficient is also statistically significant at the 1% level. A Saturday stay-over and a specific travel day restriction contributes to, on average, a $51 and $110 decrease in round-trip fares respectively, and are statistically significant at the 1% level. A minimum-stay and a maximum-stay requirement also decrease round-trip fares by approximately $10 on average. Customers who purchase tickets with restrictions are generally leisure travelers who have higher demand elasticities. Given a menu of choices, leisure travelers would choose a combination that would allow them to pay the least to travel, as implied by the estimated coefficient of tourist share (.1 increase of tourist share is expected to decrease round-trip fares by $21). In contrast, business travelers who have greater opportunity costs for their time would prefer more flexibility when travelling to accommodate last-minute schedules.

A 0.1 increase in market share is expected to increase round-trip fares by $5.10, and a 0.1 increase in market concentration is expected to decrease round-trip fares by $2.8 (round-trip fares decrease with competition). Both the coefficients on market share and market concentration are statistically insignificant under cluster estimation[13]. Also, travelling to or from an airport hub is expected to increase round-trip fares by $50. A one-day increase in days prior to departure after ticket purchase would result in a decrease $0.48 in fares, on average. The purchase of a full coach fare class ticket and a one-way ticket results in an average increase of $307 and $45 on round-trip fares respectively, whereas the presence of

[13] Errors are clustered at the carrier-route level: error terms are likely to be correlated for itineraries issued by the same carrier on a particular route. The coefficients of market share and market concentration are significant without cluster estimation. It is likely that there exists a negative correlation within each carrier-route level.

Southwest and other low cost carriers is expected to decrease fares by approximately $100 and $36 respectively.

	Round-trip fare
Market Structure Variables	
Market Share	51.388158
	(59.941240)
HHI	-28.837373
	(68.478187)
Hub	50.057632
	(20.611945)*
Slot Restricted Airport	87.100469
	(32.870184)**
Ticket Characteristics	
Advance Purchase Restriction	
[Omitted: No advance purchase restriction]	
1-day	-143.218862
	(47.968022)**
3-day	54.266518
	(28.881221)
5-day	-192.327519
	(27.745789)**
7-day	-44.484323
	(15.846246)**
10-day	-62.518663
	(16.946571)**
14-day	-60.285684
	(13.084102)**
21-day	-50.006183
	(18.310591)**
30-day	27.260116
	(35.055119)
Non-refundable	-198.547479
	(47.724305)**
Saturday stay-over	-51.822448
	(7.188859)**
Travel restriction	-110.407665
	(11.474846)**
Minimum stay requirement	-12.519276
	(12.720955)
Maximum stay restriction	-9.649725
	(13.617966)
Days prior to departure after ticket purchase	-0.483676
	(0.142180)**
Full coach fare class	307.276664
	(57.527585)**
One-way	45.713543
	(7.809944)**

Route-specific characteristics	
Presence of low cost carriers	-36.298352
	(19.305641)
Presence of Southwest airlines	-100.943438
	(29.792047)**
Distance	0.428587
	(0.098781)**
Distance squared	-0.000095
	(0.000032)**
Tourist	-214.690205
	(109.384709)
Average Population	0.000002
	(0.000008)
Average Per-capita Income	-0.003283
	(0.003373)
Constant	503.760289
	(154.008212)**
Carrier fixed effects	Yes
R^2	0.49
N	453,347

*To read the table: The regression coefficients are the numbers above the brackets. The numbers within the brackets are the corresponding standard deviation of the estimates. * represents significance at the 5% level, and ** represents significance at the 1% level*

Regression equation:

$$P_{ijk} = \beta_0 + \beta_1 R_{ijk} + \beta_2 HHI_i + \beta_3 MS_{ij} + \beta_4 Dist_i + \beta_5 DistSq_i + \beta_6 AvgPop_i + \beta_7 AvgInc_i + \beta_8 Hub_{ij} + \beta_9 Slots_i + \beta_{10} OneWay_{ijk} + \beta_{11} TicketClass_{ijk} + \beta_{12} Days_{ijk} + \beta_{13} LCC_i + \beta_{14} SW_i + \beta_{15} Tourist + \varepsilon_{ijk}$$

Table 7: Regression estimates of restricted model.

6.2.2 Unrestricted Model

In this section, I analyze the effect of market concentration on price discrimination for each separate ticket restriction. Table 8 provides the coefficients estimates of the unrestricted model under the non-refundable ticket restriction, for which I obtain the competition effect equation of $\frac{\partial P_{ijk}}{\partial R_{ijk}} = -138.41 + 24.71 HHI_i - 260.36 MS_{ij}$. The equation implies that holding market share constant, an increase in market concentration would lead to a decrease in price discrimination (i.e. a higher price for a non-refundable ticket). The results are not statistically significant at any level[14] under the assumption that errors are clustered. However, the sign of the estimated coefficient is consistent with the competitive type price discrimination theory.

[14] Coefficients are significant when standard errors are not clustered

According to Borenstein (1985) and Holmes (1989), carriers segment their market based on different consumer demand elasticities, and compete with each other within these segments. Price discrimination increases with competition when carriers lower their fares for leisure travelers and charge business travelers higher fares using its unique market niche. Similar results hold for the minimum-stay and maximum-stay ticket restriction[15].

	Round-trip fare
Interaction terms	
Market share * Non-refundable	-260.368368
	(176.033133)
HHI * Non-refundable	24.714838
	(321.614540)
Market structure variables	
Market share	272.170725
	(182.548661)
HHI	-57.970199
	(301.028642)
Hub	49.738963
	(22.523207)*
Slot restricted airport	85.066979
	(34.864624)*
Ticket characteristics	
Non-refundable	-138.410798
	(151.383587)
Days prior to departure after ticket purchase	-1.621332
	(0.176057)**
Full coach fare class	312.628219
	(47.549918)**
One-way	79.484790
	(7.996727)**
Route specific characteristics	
Presence of low cost carrier	-32.946715
	(18.958434)
Presence of Southwest airlines	-97.705760
	(30.383746)**
Distance	0.404993
	(0.107354)**
Distance squared	-0.000090
	(0.000035)*
Tourist share	-238.400054
	(117.005072)*
Average population	0.000002
	(0.000009)

[15] refer Table 22 and Table 23

Average per-capita income	-0.005032
	(0.003760)
Constant	464.702587
	(224.620956)*
Carrier Fixed Effects	Yes
R^2	0.44
N	453,347

*To read the table: The regression coefficients are the numbers above the brackets. The numbers within the brackets are the corresponding standard deviation of the estimates. * represents significance at the 5% level, and ** represents significance at the 1% level*

Regression equation:

$$P_{ijk} = \beta_0 + R_{ijk}(\gamma_0 + \gamma_1 HHI_i + \gamma_2 MS_{ij}) + \beta_1 HHI_i + \beta_2 MS_{ij} + \beta_3 Dist_i + \beta_4 DistSq_i + \beta_5 AvgPop_i + \beta_6 AvgInc_i + \beta_7 Hub_{ij} + \beta_8 Slots_i + \beta_9 OneWay_{ijk} + \beta_{10} TicketClass_{ijk} + \beta_{11} Days_{ijk} + \beta_{12} LCC_i + \beta_{13} SW_i + \beta_{15} Tourist + \varepsilon_{ijk}$$

Table 8: Regression estimates of the unrestricted model under non-refundable ticket restrictions

On the other hand, the coefficient estimates under Saturday stay-over restriction illustrates the opposite relationship between price discrimination and competition. Based on Table 9, I acquire the equation $\frac{\partial P_{ijk}}{\partial R_{ijk}} = -27.51 - 0.07 HHI_i - 90.37 MS_{ij}$, which implies that as market concentration increases, price discrimination increases, holding market share constant. The difference in expected sign may be due to the presence of low cost carriers. Low cost carriers generally target consumers with high demand elasticities such as tourists; hence, they might segment their consumers differently when compared to regular carriers. It is likely that consumers travelling using low cost carriers are more similar to each other (a larger, more diverse group of leisure travelers and a few business travelers) than consumers travelling with a regular carrier (a combination of less leisure travelers and more business travelers). Therefore, the competitive price discrimination model might not apply perfectly in this context. Furthermore, although ticket restrictions are all price discrimination measures, they are inherently different pricing strategies such that low cost carriers might discriminate more using one price discrimination measure than the other. It is plausible that Saturday night stay does not fall under this category, as the effect of price discrimination is visibly reduced as competition increases. The coefficient estimates under the travel day restriction also exhibits the same results[16].

	Round-trip fare
Interaction terms	
Market share * Saturday stay-over	-90.375475
	(48.422481)
HHI * Saturday stay-over	-0.075416
	(102.082007)
Market structure variables	
Market share	79.938790
	(67.659713)
HHI	-2.833886
	(93.300872)
Hub	46.056635
	(21.254146)*
Slot restricted airport	91.532341
	(31.194501)**
Ticket characteristics	
Saturday stay-over	-27.510922
	(44.184869)
Days prior to departure after ticket purchase	-1.628965
	(0.176585)**
Full coach fare class	436.558772
	(62.696616)**
One-way	92.037836
	(9.558614)**
Route specific characteristics	
Presence of low cost carrier	-48.745301
	(19.645793)*
Presence of Southwest airlines	-73.628582
	(27.863062)**
Distance	0.307097
	(0.095685)**
Distance squared	-0.000060
	(0.000032)
Tourist share	-180.314800
	(109.650615)
Average population	0.000002
	(0.000008)
Average per capita income	-0.003003
	(0.003087)
Constant	268.800337
	(134.378329)*
Carrier fixed effects	Yes
R^2	0.38

[16] refer Table 21

N	453,347

*To read the table: The regression coefficients are the numbers above the brackets. The numbers within the brackets are the corresponding standard deviation of the estimates. * represents significance at the 5% level, and ** represents significance at the 1% level*

Regression equation:

$$P_{ijk} = \beta_0 + R_{ijk}(\gamma_0 + \gamma_1 HHI_i + \gamma_2 MS_{ij}) + \beta_1 HHI_i + \beta_2 MS_{ij} + \beta_3 Dist_i + \beta_4 DistSq_i + \beta_5 AvgPop_i + \beta_6 AvgInc_i + \beta_7 Hub_{ij} + \beta_8 Slots_i + \beta_9 OneWay_{ijk} + \beta_{10} TicketClass_{ijk} + \beta_{11} Days_{ijk} + \beta_{12} LCC_i + \beta_{13} SW_i + \beta_{15} Tourist + \varepsilon_{ijk}$$

Table 9: Regression estimates of the unrestricted model under Saturday stay-over ticket restrictions

7. Conclusion

This paper measures price dispersion of fares across different airlines and routes using the Gini coefficient, calculated based on data obtained from the most recent time period. It also examines the relationship between price dispersion and different measures of competition: market share and market concentration; and investigates the effect of market competition on price discrimination. Basic correlations show that price dispersion decreases with market concentration and increases with market share. One possible explanation for the negative correlation between price dispersion and market concentration is that airlines compete on different consumer segments. On the other hand, the positive correlation between price dispersion and market concentration can be explained by customers' participation in frequent flyer plans as a result of origin and destination airport dominance by certain airlines. The analysis also indicates that the presence of airline hubs in origin and destination airports induces some difference in correlation coefficient signs of price dispersion and market share for different subgroups. The presence of competition in routes where an airline possesses a huge market share can cause price dispersion to correlate negatively with market share. I find that price discrimination increases with market competition only for certain ticket restrictions such as non-refundable, minimum-stay and maximum-stay tickets. It is likely that the competitive price discrimination model does not hold under the presence of low cost carriers due to different market segmentation between regular and low cost carriers. A limitation of the method used in this paper is that it is unable to isolate the effect of price discrimination via market competition; and take into account other factors influencing price dispersion, such as cost variations.

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Appendix

Airline	Mean	Standard Deviation	N	Min	Max	25th percentile	50th percentile	75th percentile	Skewness
American	179.1	34.3	30	117.0	243.0	143.0	184.0	194.5	-0.128
Delta	176.4	47.0	2272	10.5	281.5	145.0	171.5	208.5	-0.142
Frontier	162.7	54.2	592	33.0	280.5	134.0	155.8	186.3	0.249
AirTran	149.4	47.5	10	111.0	232.0	120.5	120.5	163.0	1.008
Spirit	77.2	37.8	2014	11.0	225.0	50.0	64.0	95.0	1.090
United	183.0	43.3	248	99.0	281.0	146.5	179.0	217.3	0.413
US	219.2	38.8	18	169.0	275.0	200.5	206.0	247.5	0.218
Southwest	161.0	40.6	860	84.5	280	112.75	153.3	177	217.5

Table 10: Descriptive statistics of fares from DTW to DEN on different airlines

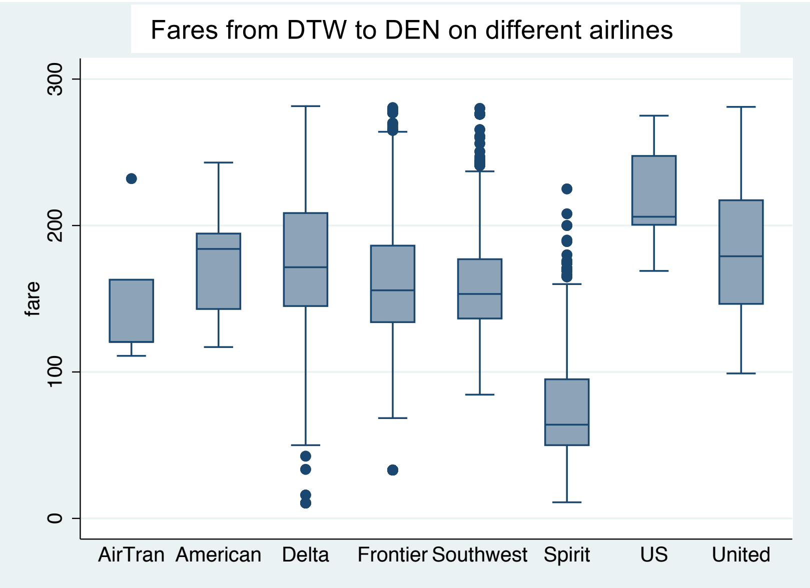

Figure 3: Boxplot of fares from DTW to DEN on different airlines

Airline	Mean	Standard Deviation	N	Min	Max	25th percentile	50th percentile	75th percentile	Skewness
American	217.5	86.8	549	63.0	451.0	160.5	169.0	265.0	1.194
Delta	233.6	100.9	1238	10.5	451.0	160.5	179.0	316.5	0.725
Spirit	117.1	39.3	800	11.0	320.0	89.0	114.0	150.0	0.483
US	227.9	81.8	98	109.5	411.0	150.0	210.0	292.0	0.406

Table 11: Descriptive statistics of fares from DTW to DFW on different airlines

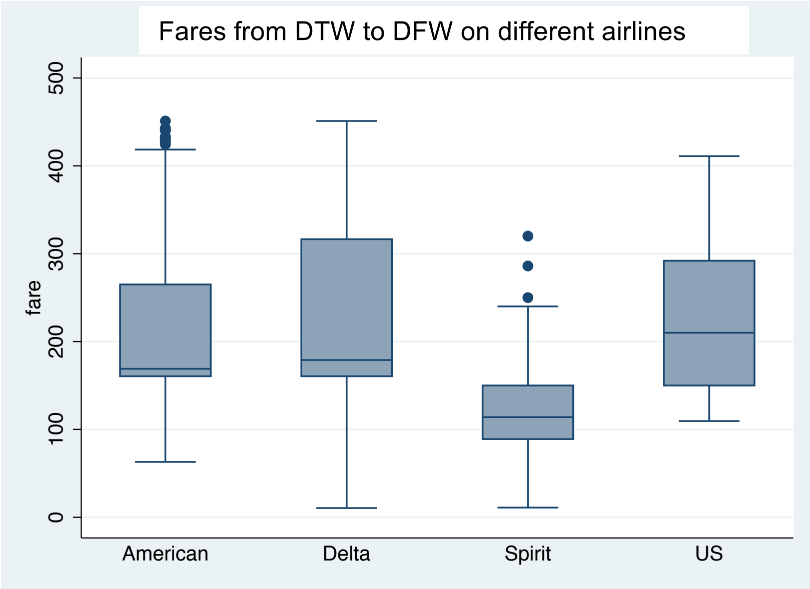

Figure 4: Boxplot of fares from DTW to DFW on different airlines

Airline	Mean	Standard Deviation	N	Min	Max	25th percentile	50th percentile	75th percentile	Skewness
American	192.3	38.3	23	145.5	273.5	157.0	190.0	221.0	0.653
Delta	197.5	45.9	3342	10.5	286.5	168.5	195.0	228.5	-0.701
Frontier	149.9	41.4	78	44.0	282.0	128.0	146.0	161.5	0.589
AirTran	162.9	37.7	18	80.5	243.0	150.0	170.5	173.5	0.072
Spirit	147.8	36.1	3014	60.0	283.0	125.0	145.0	170.0	0.296
United	181.1	34.9	34	119.0	265.5	154.0	172.0	205.0	0.768
US	199.8	39.8	140	69.5	277.5	169.5	213.0	219.0	-0.436
Southwest	176.9	33.6	1023	107.5	284.0	153.0	169.5	196.5	0.884

Table 12: Descriptive statistics of fares from DTW to LAS on different airlines

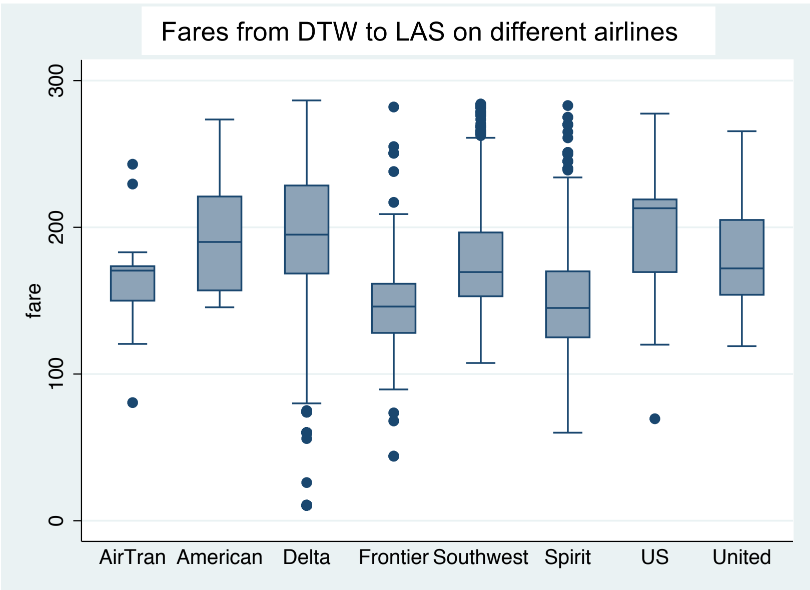

Figure 5: Boxplot of fares from DTW to LAS on different airlines

Airline	Mean	Standard Deviation	N	Min	Max	25th percentile	50th percentile	75th percentile	Skewness
American	226.9	94.4	80	51	522	155.5	207.5	271.0	0.982
Delta	254.7	105.1	2081	10.5	535	183.5	224.5	332.0	0.759
Frontier	170.3	74.3	84	26.0	458.0	142.0	148.0	178.0	2.640
Spirit	171.0	58.2	703	65.0	438.0	130.0	155.0	198.5	1.309
United	280.1	102.9	75	105.5	522.0	191.5	269.0	340.0	0.742
US	277.0	86.6	217	125.0	499.0	201.0	262.0	350.0	0.196
Southwest	184.8	73.3	439	110.0	534.0	141.5	161.5	199.0	2.574

Table 13: Descriptive statistics of fares from DTW to LAX on different airlines

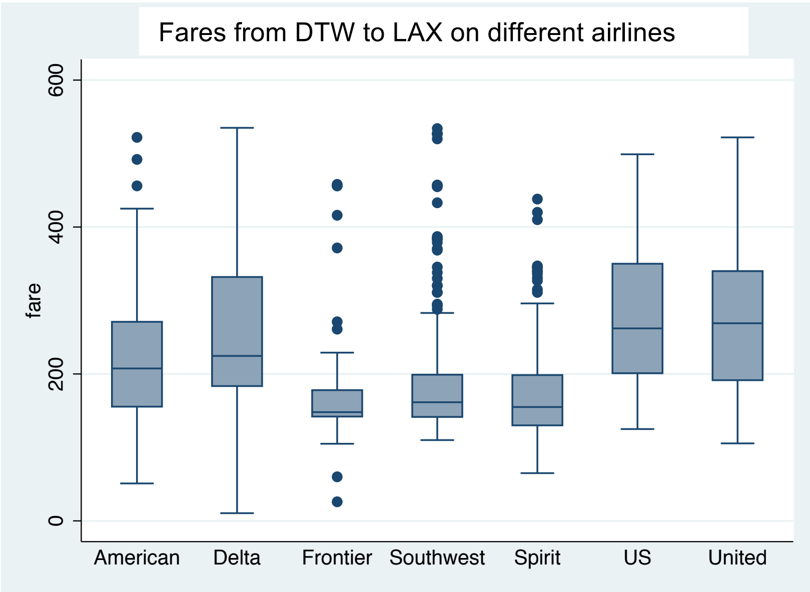

Figure 6: Boxplot of fares from DTW to LAX on different airlines

Airline	Mean	Standard Deviation	N	Min	Max	25th percentile	50th percentile	75th percentile	Skewness
American	174.2	98.7	954	53.0	511.0	134.0	140.0	165.5	2.415
Delta	197.3	109.1	4392	10.5	511.5	136.5	151.0	194.0	1.678
Spirit	111.4	37.4	3460	40.0	225.0	76.0	107.5	143.0	0.359
United	234.1	92.2	12	131.0	357.0	157.5	216.0	327.0	0.191
US	195.4	70.5	792	71.0	495.0	142.8	176.0	232.0	1.083
Southwest	193.6	82.2	188	105.5	382.5	132.0	176.0	212.5	1.218

Table 14: Descriptive statistics of fares from DTW to LGA on different airlines

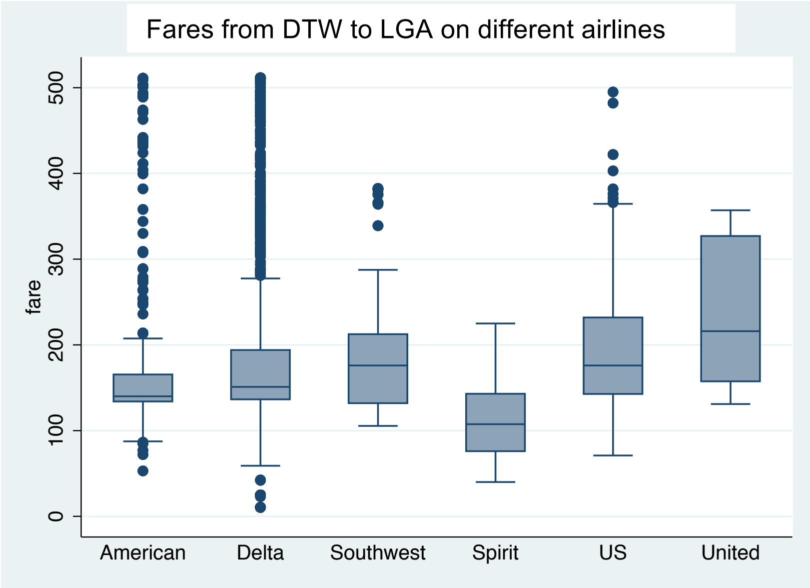

Figure 7: Boxplot of fares from DTW to LGA on different airlines

Airline	Mean	Standard Deviation	N	Min	Max	25th percentile	50th percentile	75th percentile	Skewness
American	201.3	42.4	22	159.5	321.5	172.0	189.3	199.5	1.900
Delta	218.9	67.3	1457	10.5	385.5	183.0	210.5	243.0	0.347
Frontier	199.8	49.6	32	144.0	363.0	161.0	187.0	230.0	1.388
United	212.9	76.8	47	79.0	356.5	166.6	221.5	255.0	-0.364
US	205.6	54.9	528	120.0	384.5	177.0	187.0	220.3	1.374
Southwest	211.2	50.2	631	112.5	384.0	182.0	201.0	224.5	1.147

Table 15: Descriptive statistics of fares from DTW to PHX on different airlines

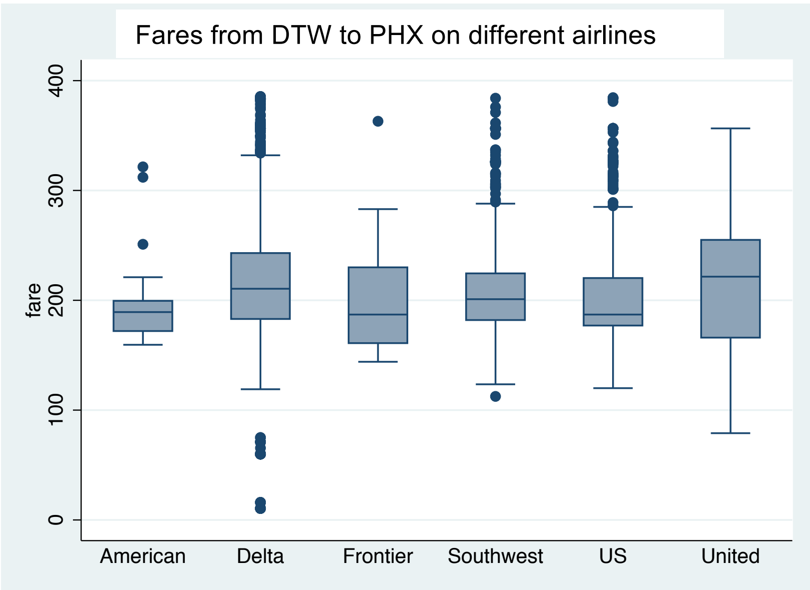

Figure 8: Boxplot of fares from DTW to PHX on different airlines

Airline	Mean	Standard Deviation	N	Min	Max	25th percentile	50th percentile	75th Percentile	Skewness
American	287.7	112.0	25	109.0	508.0	196.0	285.0	340.0	0.431
Delta	289.6	105.2	824	10.5	561.0	245.5	282.5	348.0	0.174
Frontier	239.2	70.4	45	123.0	394.0	175.0	247.0	272.0	0.355
United	228.5	114.9	38	109.0	493.0	119.5	207.5	300.0	0.829
US	285.9	107.5	114	26.0	549.0	213.0	283.0	355.0	0.091
Southwest	240.8	93.8	142	120.0	553.0	178.0	240.8	276.5	1.100

Table 16: Descriptive statistics of fares from DTW to SEA on different airlines

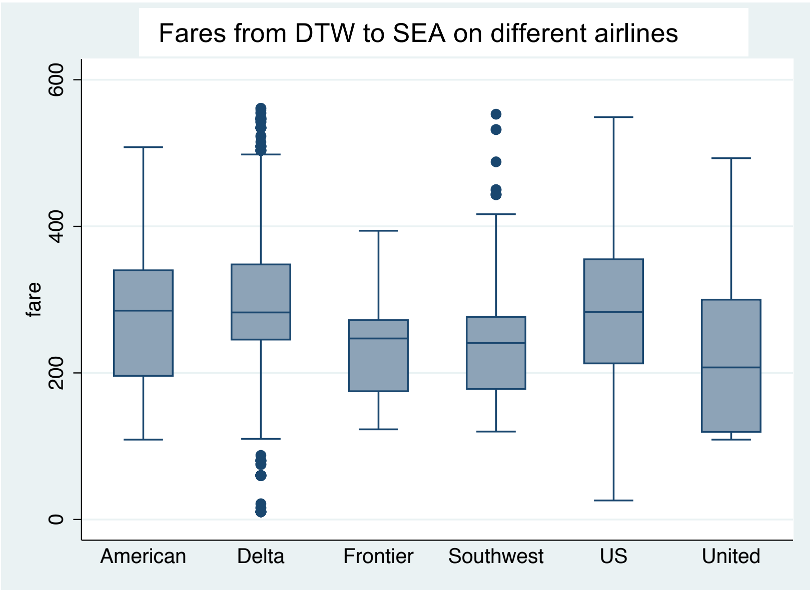

Figure 9: Boxplot of fares from DTW to SEA on different airlines

Airline	Mean	Standard Deviation	N	Min	Max	25th percentile	50th percentile	75th percentile	Skewness
American	244.5	117.1	37	15.5	575.0	176.0	216.5	274.0	1.021
Delta	285.8	120.1	1590	10.5	605.0	206.5	252.0	340.5	0.727
Frontier	238.4	76.6	37	75.0	422.0	192.0	227.0	277.0	0.425
AirTran	216.0	63.3	11	132.0	397.5	132.0	227.0	282.0	-0.171
United	322.2	115.6	81	102.0	597.0	229.0	308.0	405.0	0.624
US	295.8	89.9	147	33.0	557.0	246.0	283.0	354.0	0.021
Southwest	233.6	80.4	198	35.0	552.0	174.0	226.0	281.5	1.254

Table 17: Descriptive statistics of fares from DTW to SFO on different airlines

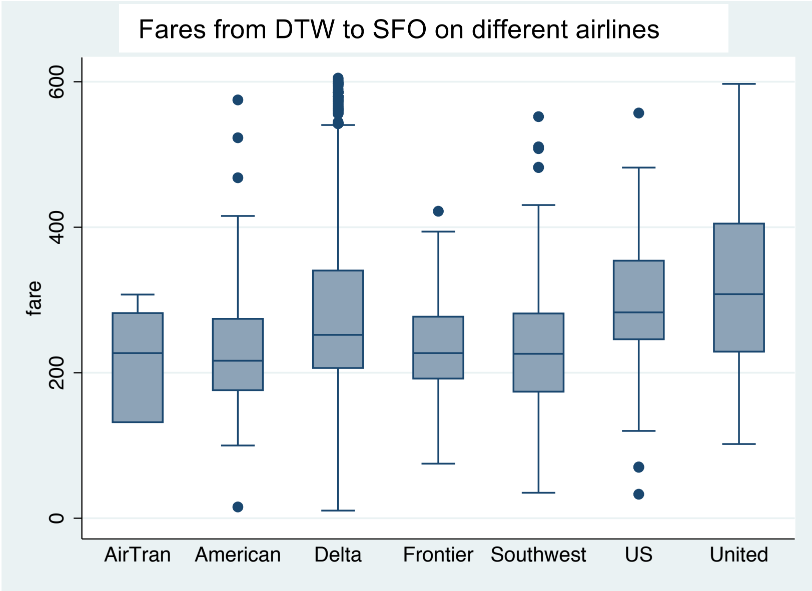

Figure 10: Boxplot of fares from DTW to SFO on different airlines

Variable Description	Mean	Standard Deviation	Min	Max
Round-trip fare	376.4978	294.4865	61.99525	3860.002
Market Structure Variables				
Market Share	0.5385714	0.2520368	0.000059	1
HHI	0.5315661	0.1891035	0.1892121	1
Hub	0.7322052	0.4428106	0	1
Slot Restricted Airport	0.2540218	0.4353104	0	1
Ticket Characteristics				
Advance Purchase Restriction				
0-day	0.3999497	0.4898882	0	1
1-day	0.0174105	0.1307953	0	1
3-day	0.0851643	0.2791264	0	1
5-day	0.0009706	0.0311387	0	1
7-day	0.2013381	0.4010005	0	1
10-day	0.0238978	0.152731	0	1
14-day	0.2439588	0.4294687	0	1
21-day	0.0238581	0.1526072	0	1
30-day	0.0034521	0.0586531	0	1
Non-refundable	0.816421	0.3871409	0	1
Saturday stay-over	0.1954375	0.3965375	0	1
Travel restriction	0.441033	0.4965113	0	1
Minimum stay required	0.2407825	0.427559	0	1
Maximum stay restriction	0.2107878	0.4078684	0	1
Days prior to departure after ticket purchased	15.86586	20.722	0	202
Full coach fare class	0.089137	0.2849417	0	1
One-way	0.2337481	0.4232143	0	1
Route Specific Characteristics				
Presence of low-cost carriers	0.4667308	0.4988925	0	1
Presence of Southwest	0.0644275	0.2455131	0	1

Distance	956.0081	636.2608	185	2704
Tourist share	0.5611523	0.0689261	0.4055	0.7605
Average population	1975896	1581949	233014.6	5974809
Average per-capita income	36546.15	3396.173	23808	45046.49

Table 18: Descriptive statistics

	Advance purchase	Non-refundable	Saturday stay-over	Travel restriction	Minimum stay	Maximum stay
Advance purchase	1					
Non-refundable	0.4149	1				
Saturday stay-over	0.3042	0.1915	1			
Travel restriction	0.2516	0.2885	0.1962			
Minimum stay	0.3566	0.2667	0.1649	0.2822	1	
Maximum stay	0.1970	0.2451	0.1199	0.2968	0.6006	1

Table 19: Correlations between each type of ticket restrictions

Destination	Airline	Gini
BOS	American	0.2650
	Delta	0.2360
	United	0.2756
	US	0.1835
	Southwest	0.1787
DEN	American	0.1086
	Delta	0.1461
	Frontier	0.1814
	AirTran	0.1693
	Spirit	0.2622
	United	0.1344
	US	0.1020
	Southwest	0.1359
DFW	American	0.2026
	Delta	0.2302
	Spirit	0.1882
	US	0.2045
LAS	American	0.1134
	Delta	0.1269
	Frontier	0.1423
	AirTran	0.1260
	Spirit	0.1367
	United	0.1073
	US	0.1118
	Southwest	0.1041
LAX	American	0.2259

	Delta	0.2226
	Frontier	0.1792
	Spirit	0.1793
	United	0.2047
	US	0.1793
	Southwest	0.1781
LGA	American	0.2350
	Delta	0.2569
	Spirit	0.1906
	United	0.2261
	US	0.1956
	Southwest	0.2209
PHX	American	0.1011
	Delta	0.1621
	Frontier	0.1314
	United	0.2004
	US	0.1365
	Southwest	0.1260
SEA	American	0.2210
	Delta	0.1985
	Frontier	0.1675
	United	0.2798
	US	0.2135
	Southwest	0.2092
SFO	American	0.2562
	Delta	0.2285
	Frontier	0.1811
	AirTran	0.1712
	United	0.2020
	US	0.1691
	Southwest	0.1822

Table 20: Gini coefficient of fares from DTW to different destinations on different airlines

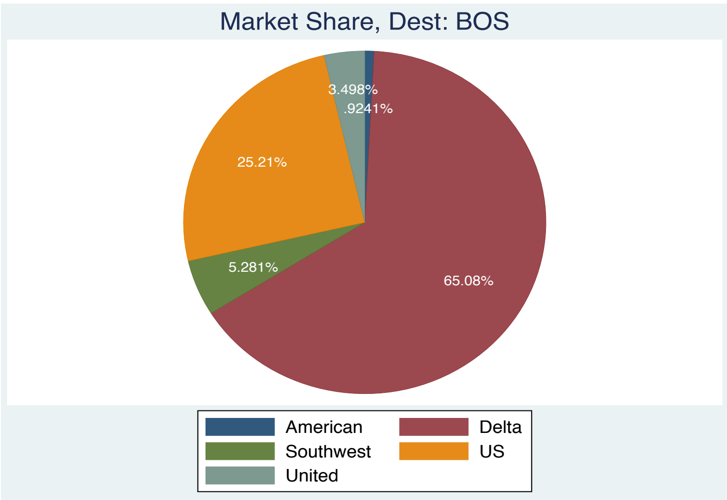

Figure 11: Market share, by proportion of total customers flying from DTW to BOS

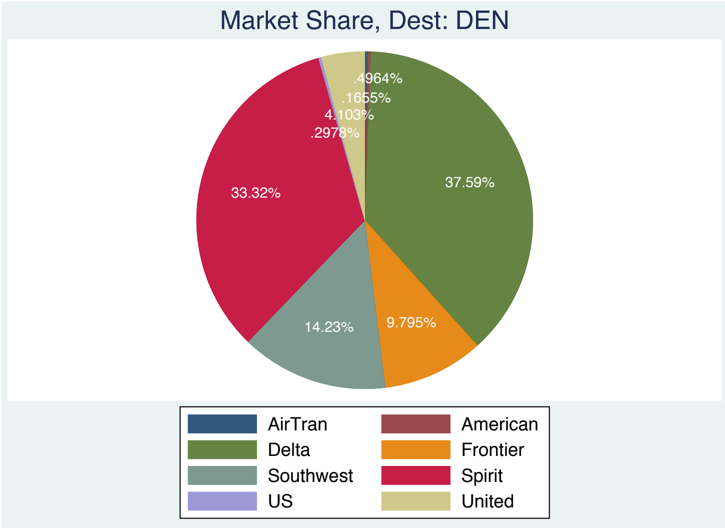

Figure 12: Market share, by proportion of total customers flying from DTW to DEN

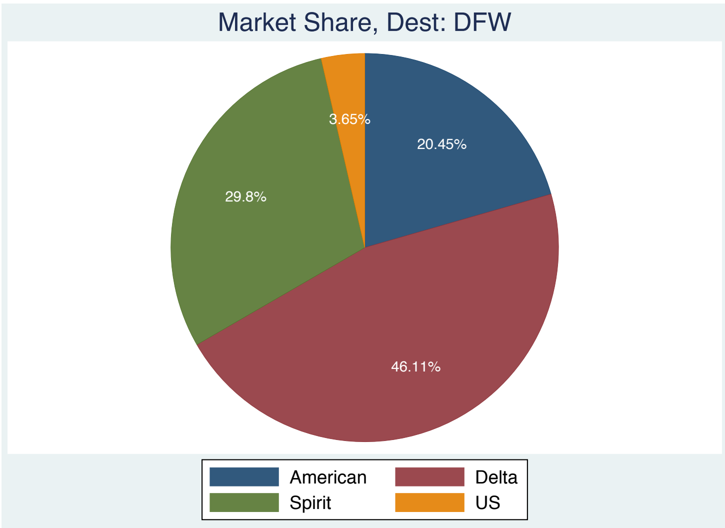

Figure 13: Market share, by proportion of total customers flying from DTW to DFW

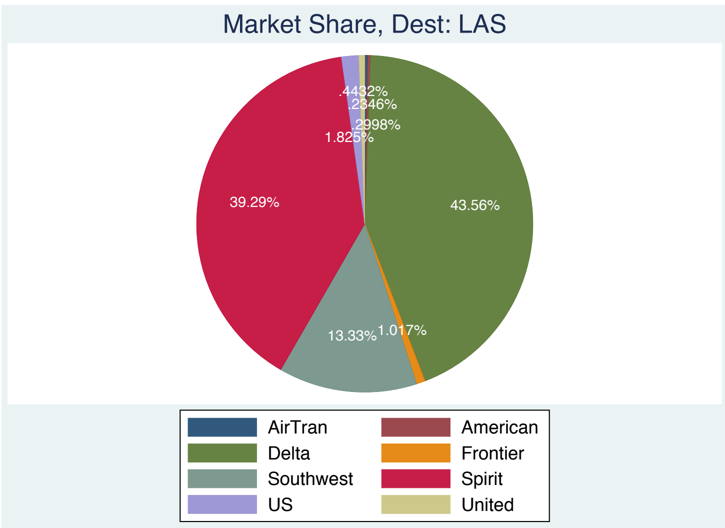

Figure 14: Market share, by proportion of total customers flying from DTW to LAS

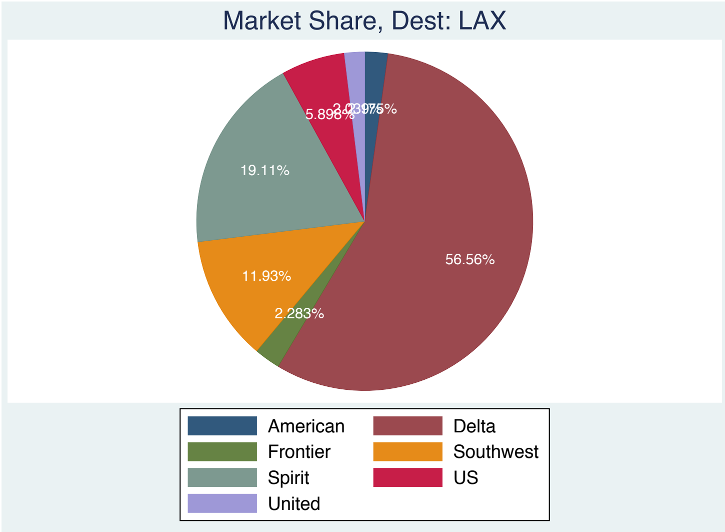

Figure 15: Market share, by proportion of total customers flying from DTW to LAX

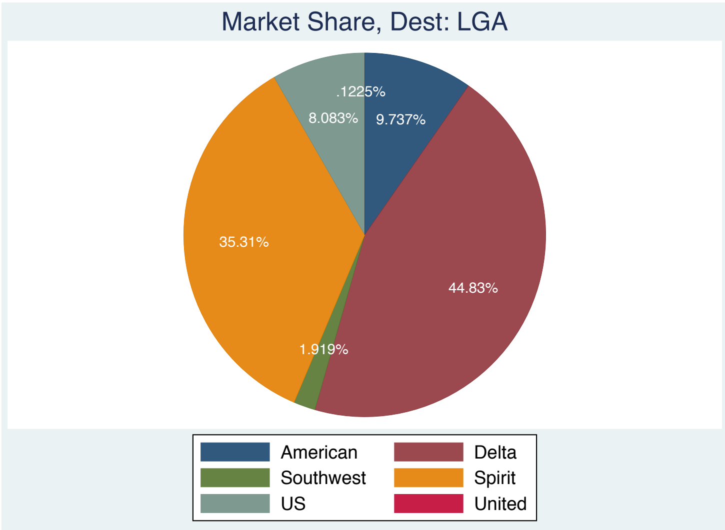

Figure 16: Market share, by proportion of total customers flying from DTW to LGA

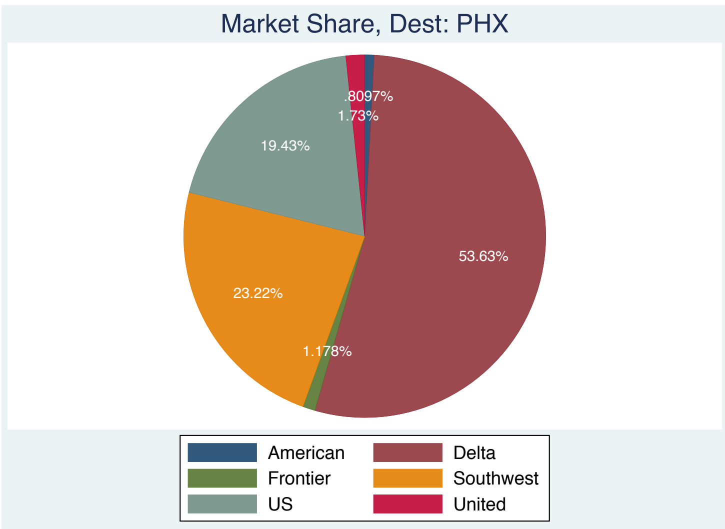

Figure 17: Market share, by proportion of total customers flying from DTW to PHX

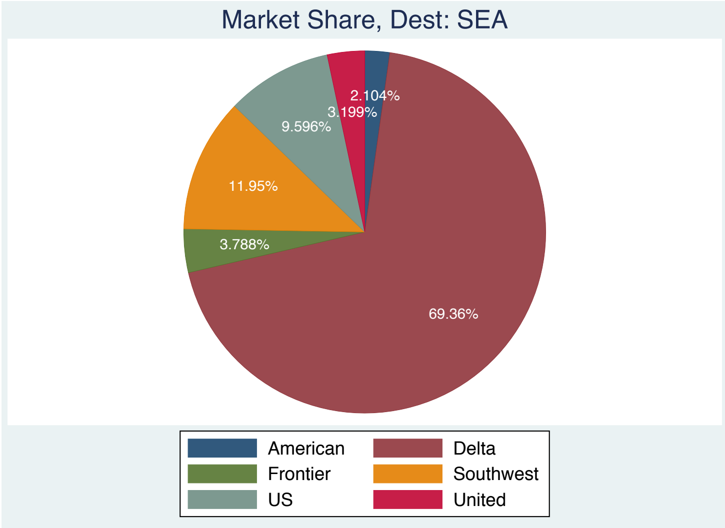

Figure 18: Market share, by proportion of total customers flying from DTW to SEA

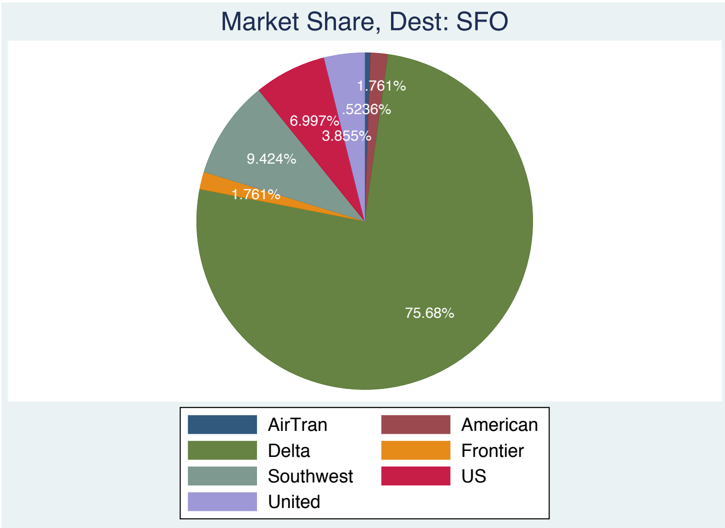

Figure 19: Market share, by proportion of total customers flying from DTW to SFO

	Round-trip fare
Interaction terms	
Market share * travel restriction	-59.705099
	(77.637573)
HHI * travel restriction	-29.182481
	(151.430863)
Market structure variables	
Market share	71.227245
	(84.892653)
HHI	-17.845604
	(126.582190)
Hub	52.793239
	(20.763081)*
Slot restricted airport	94.605681
	(32.460102)**
Ticket characteristics	
Travel restriction	-96.518513
	(64.319148)
Days prior to departure after ticket purchase	-1.622273
	(0.188452)**
Full coach fare class	401.832913
	(60.962708)**
One-way	82.473387
	(8.312461)**
Route specific characteristics	
Presence of low cost carrier	-46.184173
	(18.958854)*
Presence of southwest airlines	-67.345890
	(25.648847)**
Distance	0.328027
	(0.095397)**
Distance squared	-0.000067
	(0.000031)*
Tourist share	-186.802805
	(106.299543)
Average population	0.000000
	(0.000008)
Average per capita income	-0.001078
	(0.003039)
Constant	259.472111
	(138.938311)
Carrier fixed effects	Yes
R^2	0.42
N	453,347

Table 21: Regression estimation under the unrestricted model under travel day restriction

	Round-trip fare
Interaction terms	
Market share * minimum stay	-49.888820
	(72.219130)
HHI * minimum stay	91.307262
	(156.693338)
Market structure variables	
Market share	61.849472
	(71.575805)
HHI	-7.260193
	(109.103447)
Hub	63.010534
	(22.330121)**
Slot restricted airport	96.726275
	(32.153138)**
Ticket characteristics	
Minimum stay	-119.507432
	(62.646027)
Days prior to departure after ticket purchase	-1.755286
	(0.174059)**
Full coach fare class	428.422034
	(61.284509)**
One-way	92.918703
	(8.697131)**
Route specific characteristics	
Presence of low cost carrier	-62.022506
	(21.751606)**
Presence of southwest airlines	-86.918154
	(30.328195)**
Distance	0.297701
	(0.094437)**
Distance squared	-0.000055
	(0.000031)
Tourist share	-203.825335
	(115.372924)
Average population	0.000001
	(0.000008)
Average per-capita income	-0.003867
	(0.003207)
Constant	333.946671
	(140.093845)*
Carrier fixed effects	Yes
R^2	0.39
N	453,347

Table 22: Regression estimation under the unrestricted model under minimum stay

	Round-trip fare
Interaction terms	
Market share * maximum stay	-20.800451
	(56.950656)
HHI * maximum stay	41.673178
	(119.323412)
Market structure variables	
Market share	55.947121
	(66.076193)
HHI	0.253344
	(90.358586)
Hub	62.832459
	(21.963151)**
Slot restricted airport	89.213268
	(31.930915)**
Ticket characteristics	
Days prior to departure after ticket purchase	-1.908903
	(0.193171)**
Maximum stay	-108.385313
	(46.177284)*
Full coach fare class	430.701144
	(61.829463)**
One-way	95.520709
	(9.207275)**
Route specific characteristics	
Presence of low cost carrier	-58.055047
	(20.495517)**
Presence of southwest airlines	-80.077350
	(28.855996)**
Distance	0.306766
	(0.096168)**
Distance squared	-0.000061
	(0.000032)
Tourist share	-188.769515
	(113.131006)
Average population	0.000004
	(0.000008)
Average per capita income	-0.002342
	(0.003108)
Constant	261.521804
	(137.267228)
Carrier fixed effects	Yes
R^2	0.39
N	453,347

Table 23: Regression estimation under the unrestricted model under maximum stay