The case for the merger of Delta and American Airlines

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Yifan Cai
yifan.cai2@wisc.edu
Yuxuan Xu
yxu648@wics.edu
Shijie Chen
schen998@wisc.edu
Yuchen Tian
ytian227@wisc.edu

Abstract: This paper uses historical data from the merger of Delta and Northwest Airlines in 2009 to build a reasonable random forest model to predict the price after the merger of Delta and American Airlines in 2019, observe the impact of different variables on the price, and compare the predicted price with the price before the merger. We focus on the impact of the number of airlines in the market and the market structure on the market price and find that the price increases after the merger.

1. Introduction

The aviation market has been a large-scale and highly competitive market in the past two years. The passenger volume and employee demand of the aviation industry are closely related. Every economic recession will lead to a decrease in passenger volume, thereby reducing the demand for employees. Changes in the number of employees can indirectly reflect the development of the aviation industry.

Employees at U.S. Scheduled Passenger Airlines in Month of June, 1990–2024
(Full-time equivalents)

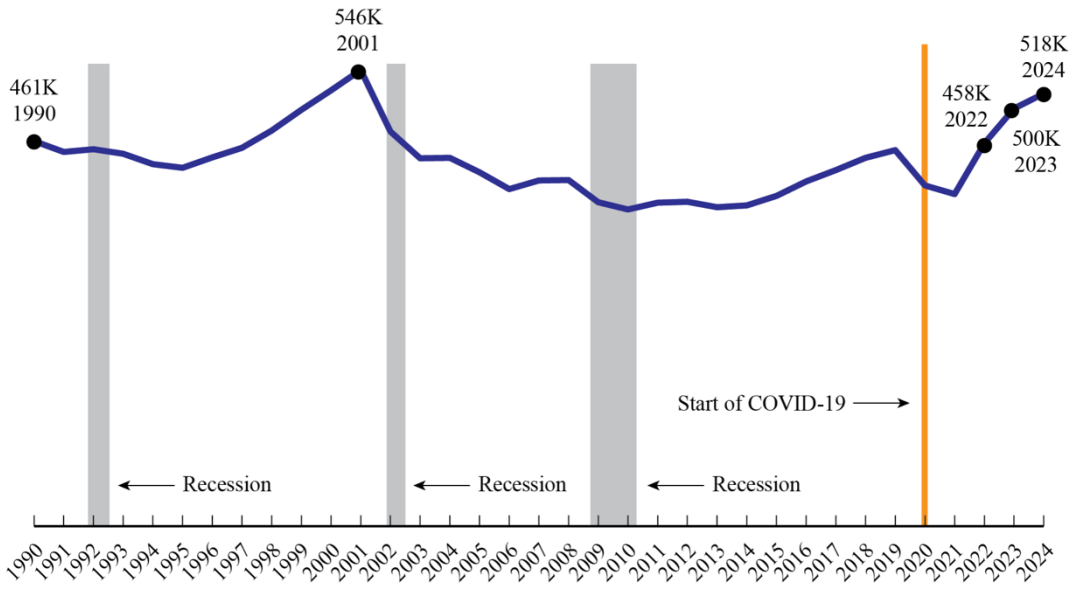

Figure 1 Employees at U.S. Scheduled Passenger Airlines in Month of June

According to Figure 1, we can see that the number of airline employees in the United States has rebounded significantly since 2013 (U.S. Bureau of Transportation Statistics, 2024). After 2013, the U.S. civil aviation industry completed important integration, pushing the aviation industry into a new stage, and the number of employees increased accordingly, reaching its peak in 2019. Therefore, the number of employees reflects the large scale and fierce competition of the aviation industry market. Large airlines seek mergers to continue to expand market share, hoping to achieve economies of scale by sharing resources and reducing costs, thereby reducing the impact of increasing operating costs.

Mergers need to comply with antitrust policies. U.S. antitrust laws will impose restrictions based on market concentration, consumer impact, and utility compensation changes. The first is market concentration. The higher the market concentration, the more likely it is that antitrust agencies will believe that mergers will reduce competition, and mergers will face stricter scrutiny; secondly, antitrust reviews will also evaluate the impact of mergers on consumers, such as whether prices have increased, whether there are fewer routes to choose from, whether innovation has been hindered, or whether service quality has declined. If a merger will cause

damage to consumer welfare, antitrust agencies may oppose the merger (Edelman*, 2021); but if the merger can reduce costs and increase efficiency, consumers will benefit. Antitrust agencies will consider this defense and evaluate whether the overall benefits of the merger can offset the adverse effects on competition.

To predict the merger of Delta and American Airlines, we will review the previous mergers of Delta Airlines. We will consider the merger of Delta and Northwest Airlines in 2009. Since Delta Airlines became the largest airline in the United States at that time after the merger, we think this successful merger case is more representative. In 2008, the global economic recession and the decline in passenger traffic caused heavy losses for most airlines, including Delta Airlines. In the context of the industry where many airlines went bankrupt, Delta Airlines chose to merge with Northwest Airlines to get out of the predicament. Since the two airlines had many overlapping routes, they were competitors on many routes. After the merger of the two companies, the service scope of the two companies covered almost all major travel markets in the world, and the service scope exceeded that of other airlines, which made Delta the largest airline in the United States at that time. After the merger of the two companies, the ticket prices were on a short-term upward trend.

Next, we will use the antitrust law restrictions to evaluate the merger of Delta Air Lines and American Airlines. In 2019, Delta Air Lines accounted for 22.69% of the US market in terms of RPM, and American Airlines accounted for 22.87% of the US market (MIT Airline Project, 2019). If Delta Air Lines and American Airlines merge, from the overall industry structure, the market concentration will be greatly increased, which will further consolidate the market dominance of large airlines and make it easier to squeeze out small airlines with lower market share, thereby reducing market competition and may attract the attention of antitrust regulators; from the perspective of customer welfare, the merger will give airlines higher bargaining power, increase prices on some main navigation routes, which is not good for customers. In addition, the merger may reduce overlapping routes, thereby reducing consumer choices; from the perspective of technological development, the two airlines can complement each other's strengths and share resources. There will be more resources for technological innovation, improving operating facilities and service quality, such as regular maintenance of aviation apps, improving customer service levels and simplifying ticket booking processes, etc. At the same time, it will also bring certain opportunities. After the merger, it may form economies of scale, reduce costs, increase profits, and more funds will be invested in the development of airlines.

In this case, we will use the random forest model to bring in different market data to analyze the impact of the merger on prices. By combining the actual merger data of Delta and WN in 2009, we can predict the price changes after the merger of DL and AA. After observing the price after the merger, we found that the price will rise briefly after the merger, which is consistent with the result of the actual merger in 2009.

2. literature review

To study the impact of airline mergers on route operations and customer experience, we studied the articles of Marc Remer, Jeff Mosteller, Christian Hofer & Reed Orchinik, etc. These three articles all pointed out that airline mergers will lead to an increase in ticket prices.

Jeff Mosteller studies the impact of airline mergers on consumers and the market. The article points out that based on the merger history of the aviation industry and combined with antitrust issues, airport restrictions find that airline mergers will also affect the integration of other airlines and maintain the competitiveness of the company through mergers. However, company mergers will lead to changes in ticket prices and adjustments in service quality. (Mosteller, 1998) The number of airlines in the market directly affects the degree of competition. Therefore, we assume that the number of airlines is proportional to the price. When the number of airlines increases, market competition intensifies. Airlines will improve user experience by formulating high-quality routes or differentiated services, which may lead to rising costs and rising ticket prices.

Christian Hofer's research examines the impact of low-cost airlines (LCCs) on the price premium of the US aviation industry. The study found that the largest component of the price premium comes from airport market share and concentration. Importantly, it shows that low-cost airlines do not charge a price premium, and competition from low-cost airlines tends to reduce the price premium of high-cost airlines. (Hofer, 2008) Therefore, we assume that the number of LCCs is inversely proportional to the price. When low-cost airlines enter the market, they are more willing to lower prices and seize market share by not charging price premiums due to their low costs. When the number of LCCs increases, it affects the price structure of the traditional market and reduces the ability of the dominant airlines to maintain high price premiums. A price war will be formed, thereby reducing the overall price level.

Reed Orchinik and Marc Remer used three retrospective methods in the article: standard double difference regression, synthetic control method and nearest neighbor matching to study four merger cases of American airlines. It was found that the merger method would also affect the prediction of price changes. They classified and discussed the changes in prices on overlapping routes and non-overlapping routes. It was found that prices were rising on both routes. (Orchinik & Remer, 2023) Therefore, we assume that market size is proportional to price. The merged airline will have a larger market share on overlapping routes. The airline will dominate the route, reflecting the airline's exclusive supply of the route, thereby having more bargaining power on this route. Therefore, when the market size expands, it will be easier for airlines to increase profits by raising prices, resulting in an increase in the overall price level.

Through these articles, we found that airline mergers will increase ticket prices and have a negative impact on consumers. Due to the reduction in market competition after the merger, the merged company obtains a larger market. The increase in market size and the reduction in the number of routes and flights lead to higher ticket prices and fewer travel options for consumers.

In the following research, we will refer to Dennis Carlton's classification method to classify the market. We regard each pair of departure and destination cities as an independent market, because passengers usually choose flights based on the departure and arrival cities when choosing flights. This method of pairing each city to form an independent market can more accurately evaluate the level of competition among airlines on each route.

3. Sample, Data, and Variables

3.1 Sample Processing

The research sample in this study comprises daily flight data from the years 2008, 2009, and 2019. The data is sourced from DB1B data, covering all domestic itineraries for each quarter of the respective years. We define a market as a combination of different origin-destination pairs. We excluded market samples with poor discussion value, such as those involving changes in ticket carriers, market samples with ticket prices below $25 or above $2,500, and market samples with an average of fewer than 20 passengers per day. This ensures that the analyzed samples are both generalizable and interpretable. For partially missing data, we manually filled in the gaps, and some demographic data was sourced from the US Census (www.census.gov) and Places US (places.us.com).

3.2 Variable Definitions

Our core research variable is price. Variable price is the ticket price for the trip, measured in US dollars. For all samples within the same market, the average value of this variable is calculated.

To capture market characteristics, we introduce the following variables:

1. **Log_distance**: The natural logarithm of the trip distance. For all samples within the same market, the average value of this variable is used. And it is treated with natural logarithm.

2. **Market Type**: Series of dummy variables. We refer to Lazarev (2013), for airlines holding a market share of 70% or more in a single market, the airline is considered a monopoly, all variables Market_type are assigned a value of 0. For markets where two airlines each hold a market share of 30% or more and the sum is greater than 80% or more, the market is considered a duopoly, and variable Market_Type2 is assigned a value of 1. Similarly, for markets where 3 airlines each hold a market share of 20% or more and the sum is greater than 80% or more, the market is considered a triopoly, and variable Market_Type3 is assigned a value of 1. For all other samples, variable Market_Type4 is assigned a value of 1. This variable reflects the competitive structure of the market.
3. **Market Size**: Market size is an important variable to capture market characteristics. Borenstein(1989) found that an airline's market share at the end of a route has a statistically significant effect on its fares. The variable is calculated as the square root

of the product of the populations of the cities where the market's origin and destination airports are located.

4. **Vacation_spot**: A dummy variable. For samples where both endpoint cities of the market are classified as vacation destinations, this variable is assigned a value of 1; otherwise, it is assigned a value of 0. This variable captures the popularity of both cities involved in the market.
5. **Slot-controlled**: A dummy variable. For samples where both endpoint airports of the market are defined as slot-controlled by the FAA, this variable is assigned a value of 1; otherwise, it is assigned a value of 0.
6. **Hub**: A dummy variable. For samples where both endpoint airports of the market are considered airline hubs, this variable is assigned a value of 1; otherwise, it is assigned a value of 0. This variable captures the technical characteristics of the market.
7. **Num_carriers**: The total number of airlines offering trips within the same market. This variable reflects how competitive the market is.
8. **Num_LCC:** This variable counts the number of low-cost airlines in the same market. Graham(2013) suggests that the entry of LCCS into the market will change the market structure and have an impact on price.

3.3 Descriptive Statistics

Table 1 shows descriptive statistics of our non-dummy variables.

Table 1 Descriptive Statistics

vars	n	mean	sd	median	min	max
Price	455818	137.62	52.14	126.2	25	1221.88
Log_distance	455818	6.62	0.69	6.73	4.43	8.53
Market size	455818	877061.29	812951.27	613085.96	6762.23	5575485.32
Num_carriers	455818	2.51	1.32	2	1	10
Num_LCC	455818	1.1	0.75	1	0	4

The mean of price (137.62) is higher than the median (126.20), indicating that the market has more share in the low-end market, but the price of the high-end market shows an extremely higher state. The variance of each variable is low relative to its order of magnitude, our data is reasonable and there are no extreme values. The sample is rich and covers a variety of statuses. It is a good overview of the diversified market.

3.4 Methodology

For predictive purposes, the methodology employed in this study is as follows:

First, we built a linear model using data from 2008 and 2009 to see if its variable coefficients were intuitive. Then, to optimize the model's fit, we replace it with a robust random forest model and record its structure. Also, we estimate the changes in various independent variables that would occur in 2019 if a merger were to take place. Finally, we use the established model and the updated data to predict the price in 2019 post-merger.

3.5 Predicting Changes in Independent Variables

To simulate the merger scenario in 2019, we need to define how each variable would change before and after the merger. Post-merger, the Market type is recalculated by giving all the shares of the merged company to the merged company, and we subtract 1 from the Number of Carriers if the merger involves Delta Airlines or American Airlines. For other variables, we assume that the merger would not affect their values.

4. Estimation and Result

4.1 Model Fitting

For data processing, 80% of the combined dataset from 2008 and 2009 was used as the training set and 20% as the test set. For the training set, the model was trained using OLS and Random Forest, respectively, and the test set was used to predict the data. The accuracy of the model is tested by comparing the difference between the predicted data obtained from the simulation and the actual data.

4.1.1 OLS Regression Result

Table 2 shows the results of OLS regression on average price in each market. All coefficients are statistically significant at the 1% level, as indicated by extremely low p-values.

The number of carriers shows a positive relationship with prices. Average distance exhibits a logarithmic relationship, with a coefficient of 40.59, suggesting that longer routes command higher prices at a decreasing rate. The presence of low-cost carriers (LCC) is associated with a $19.19 decrease in prices, highlighting their competitive impact. Hub airports and slot-controlled airports command significant price premiums of $10.04 and $10.84 respectively, which can be attributed to both elevated operating costs at these high-traffic facilities and entry barriers that limit effective competition through slot allocation systems and established network advantages. Vacation destinations see lower prices by about $14.06, possibly due to higher price elasticity of demand in leisure markets. The regression results reveal a pattern in market competition effects, with Market Type 1 (monopoly) serving as the base category. The coefficients for Market Types 2, 3, and 4 are all negative (-11.94, -13.74, and -11.00 respectively), indicating that prices in the market that has competitors are lower than in monopolistic markets. This aligns with the classical economic theory of market competition. Temporal effects are captured through both annual and quarterly variables, with a negative year trend of -$12.95 and significant seasonal variations across quarters, where Q3 shows a positive effect of $2.92 while Q1 and Q2 demonstrate negative effects of -$2.89 and -$8.40 respectively.

Table 2 Results of OLS Regression

Term	Estimate
(Intercept)	25897.6177***
	(260.23)

num_carriers	4.4883***
	(0.08)
log(Avg_Distance)	40.5926***
	(0.10)
num_LCC	-19.1904***
	(0.11)
market_size	0.0000***
	(0.00)
vacation_spot	-14.0587***
	(0.15)
slot_controlled	10.8388***
	(0.22)
hub	10.0366 ***
	(0.22)
Market_Type2	-11.9371***
	(0.18)
Market_Type3	-13.7412***
	(0.31)
Market_Type4	-10.9999***
	(0.26)
Year	-12.9544***
	(0.13)
Q1	-2.8887***
	(0.19)
Q2	-8.3978***
	(0.19)
Q3	2.9210***
	(0.19)
R-squared	0.4400

The model is statistically significant ($p < 2.2e-16$), explaining 44% of the variance in the data.

4.1.2 Random Forest Result

The table shows the results of the random forest variable regression, showing the importance of different variables in the regression separately. The data in the table, in descending order, shows that the distance between markets, market size, and the number of low-cost airlines have the greatest impact on the average market price, and play a determining factor for pricing.

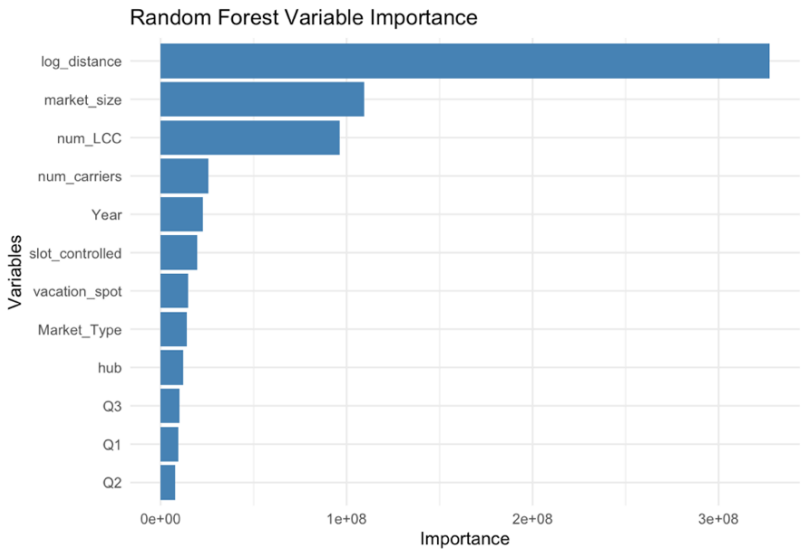

Figure 2 Random Forest Variable Importance

Based on the visualization results, the Random Forest model demonstrates superior predictive capability with well-controlled variance, as evidenced by the consistent clustering of predictions along the reference line across the price spectrum.

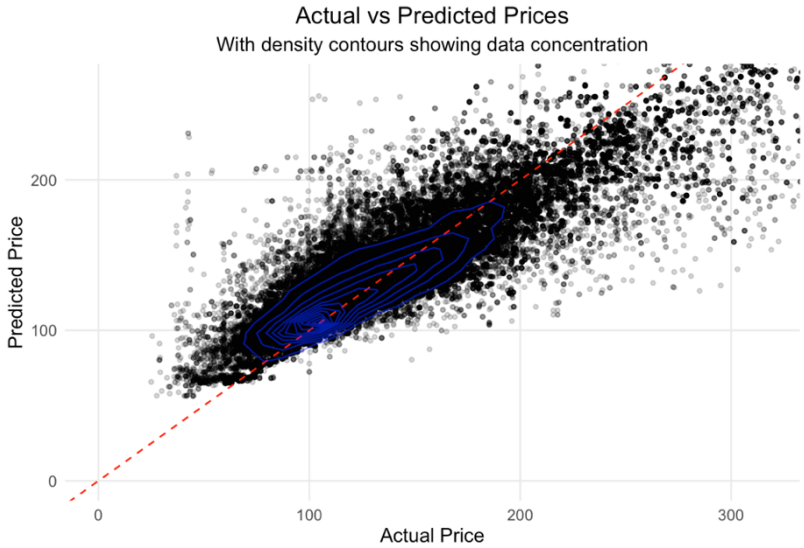

Figure 3 Actual vs Predicted Prices

As shown in Figure 4, the hexagonal binning visualization reveals crucial patterns in the prediction distribution. The highest concentration of observations, approximately 7,500 instances, clusters around price points of 100 units, suggesting a natural market equilibrium in this price range.

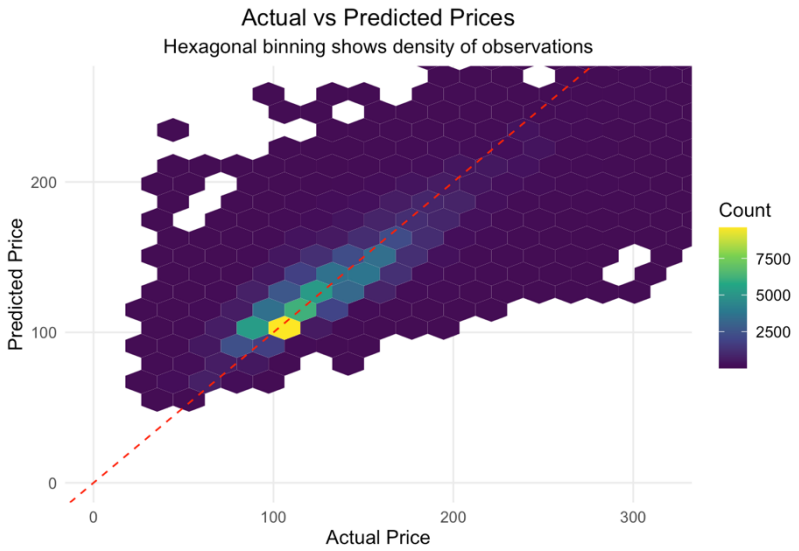

Figure 4 Actual vs Predicted Prices

The random forest model was more accurate in predicting prices compared to the linear regression model. The model was statistically reliable and predictive (R^2 = 0.76, MSE = 663.96), while the linear regression model had a higher rate of performance bias (R^2 = 0.44, MSE = 1512.98)

4.2 Backtesting

Since other variables, such as vacation spot, hub, etc., do not change in the short term except for the number of carriers in the market and the type of the market, which change after the merger, and market size, which is calculated based on the number of people at the starting and ending points and fluctuates little in the short term, we use the model to predict the post-merger price by predicting the possible changes in the variables num_carriers and market_type.

The new market type is obtained by summing all market shares owned by Northwestern Airline to Delta Airline, which presupposes that the market is not volatile in the short term. Re-assign values to the data following the Market Type construction logic. For the num_carriers variable, if there is a market with either Northwestern Airline or Delta Airline, then num_carriers is unchanged; if both carriers are present in the market, then num_carriers is reduced by one.

The random forest model demonstrates markedly superior performance over linear regression in price prediction accuracy. While linear regression shows widely scattered predictions due to its inherent linear assumptions, the random forest's ability to capture nonlinear patterns results in more precise predictions. The R-squared for linear regression prediction is 0.2236 while for random forest regression prediction is 0.4939. The Mean Square Error for linear regression is 3002.87, while for random forest regression is 1950.48.

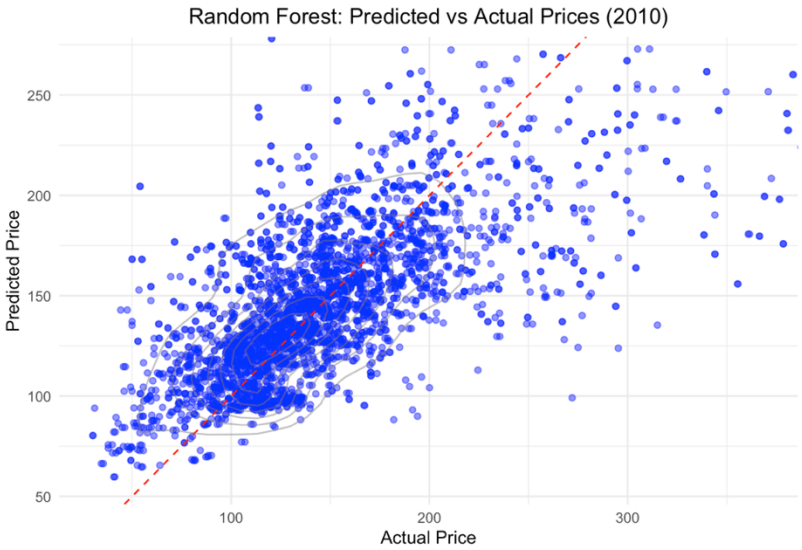

Figure 5 Random Forest: Predicted vs Actual Prices

Figure 6 Random Forest: Predicted vs Actual Prices

The random forest model shows a more favorable error distribution compared to the linear regression model. The random forest's errors are more tightly concentrated around zero, with a narrower spread. In contrast, the linear regression model displays a wider error distribution indicating larger prediction deviations.

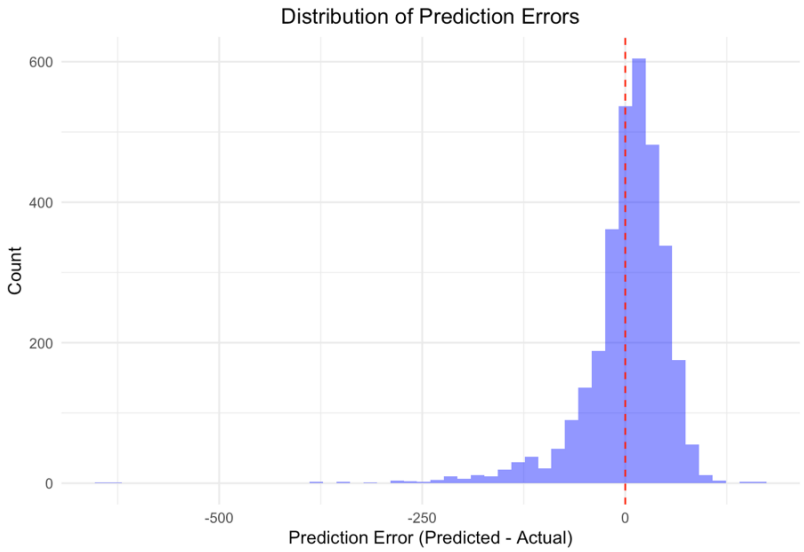

Figure 7 Distribution of prediction Errors

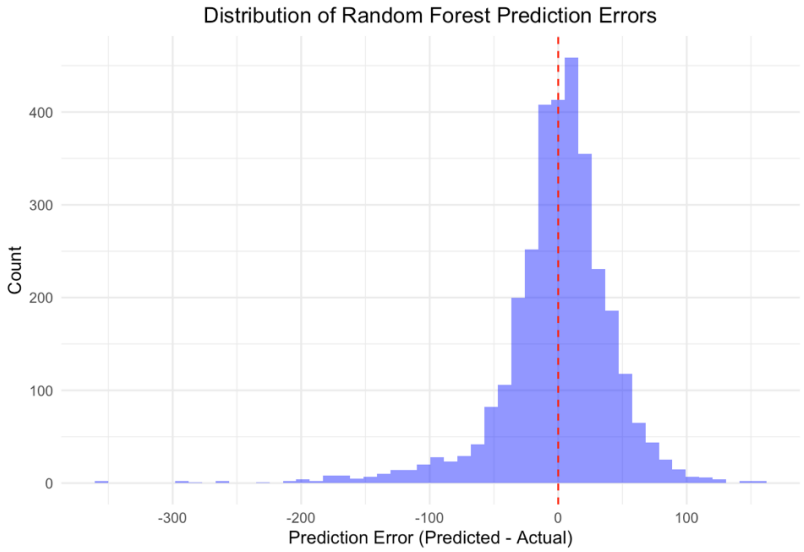

Figure 8 Distribution of Random Forest Prediction Errors

The aggregate market analysis reveals modest overall price effects following the merger, with a mean price increase of $2.22 but a median price decrease of $0.66. The weighted average price change of 1.86% exceeds both the mean and median percentage changes, indicating that larger markets experienced relatively higher price increases.

Table 3 Post-Merger Price Impact on Overall Market

Mean Price Difference	Median Price Difference	Mean Percentage Change	Median Percentage Change	Weighted Average Price Change
$2.22	$-0.66	0.9%	-0.47%	1.86%

The disaggregated analysis by market type reveals heterogeneous effects across different competitive environments. Monopoly markets show a positive mean price effect (1.52%) but a slight negative median effect (-0.163%), suggesting skewed price changes within monopolistic markets. Competitive markets demonstrate a mixed pattern with a negative mean effect (-1.22%) but a slightly positive median effect (0.715%).

Table 4 Post-Merger Price Impact Break Down by Market Types

Market Type	Price Difference Percent Mean	Price Difference Percent Median
Monopoly	1.52%	-0.163%
Duopoly	-3.13%	2.52%
Triopoly	-4.94%	-9.38%
Competitive	-1.22%	0.715%

It is worth noting that in Carlton's analysis of the Northwest and Delta merger, the log of average prices decreased by 4.4% in nonstop overlapping markets and by 3.7% in connecting overlapping markets. The discrepancy between our results and Carlton's primarily stems from the differences in the markets under consideration. However, overall, our data aligns with Carlton's simulation, showing that the magnitude of price changes is not particularly large.

Furthermore, the price changes across different markets align with economic intuition. In monopoly markets, the post-merger consolidation strengthens the pricing power, leading to price increases. In contrast, in other markets, mergers result in asset restructuring, increased capacity, reduced operational costs, and a higher number of passengers, which collectively drive ticket prices down.

4.3 Merger Prediction

Based on the backtesting results, it is clear that random forests are more accurate in predicting prices, so we use the fitted random forest model to predict the change in prices in the overall market after the merger of Delta Airline and American Airline in 2019, as well as price changes in different market types.

As demonstrated in Table 3, in the overall market, the average price increased by $15.16, the median price increased by $9.65, the average price percent increased by 9.83%, and the median price percent increased by 7.23%. After weighted averaging based on market size, the overall market has increased by 15.87% in percentage after the merger. This disparity suggests that larger markets experienced disproportionately higher price increases, indicating potential market power effects were more significant in dominant market segments. The magnitude of the weighted average effect relative to the unweighted mean provides evidence that the merger's impact was systematically larger in markets with greater economic significance.

Table 5 Post-Merger Price Impact

Mean Price Difference	Median Price Difference	Mean Percentage Change	Median Percentage Change	Weighted Average Price Change
$15.16	$9.65	9.83%	7.23%	15.87%

Post-merger price changes reveal a pronounced rightward skewness in the distribution, with a modal increase clustering around 0-50%. While the majority of price adjustments remain moderate, the distribution exhibits a notable long right tail extending beyond 300%, indicating isolated instances of extreme price escalation. This asymmetric pattern suggests that while most markets experience modest price increases post-merger, there are select markets where airlines exercise substantially greater pricing power. In general, post-merger airlines are more inclined to raise prices, possibly because as airlines become more concentrated within the market, there are fewer competitors and companies have more pricing power.

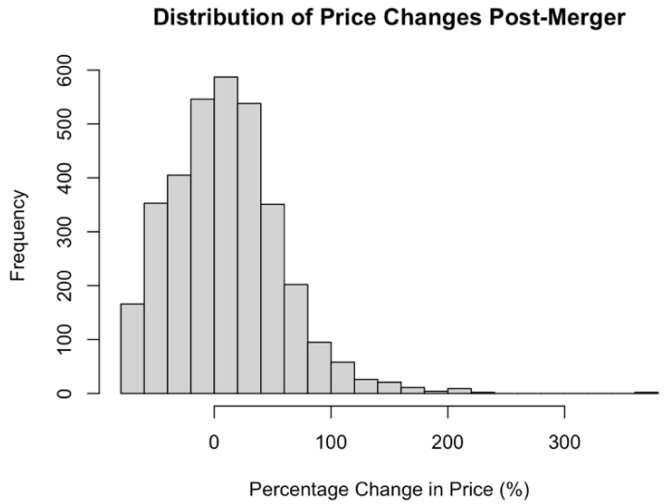

Figure 9 Distribution of Price Change Post-Merger

The table illustrates distinct patterns in price differences across market structures. Contrary to conventional economic theory, monopoly markets exhibit the lowest price differences, with a mean of 9.42% and median of 5.59%. Duopoly markets show the highest mean price difference (11.4%), while triopoly markets demonstrate a slight decrease (10.3% mean, 11.4% median). Notably, competitive markets maintain relatively high price differences (11.3% mean, 11.4% median), comparable to duopoly and triopoly structures.

There is an unexpected pattern, where monopoly markets show lower price increases than more competitive structures. One possible explanation is that monopolistic markets may already be operating at higher price levels pre-merger, leaving less room for additional price increases. Alternatively, monopolistic markets might face greater regulatory scrutiny constraining their ability to implement substantial price increases post-merger.

Table 6 Post-Merger Price Change in Different Market Type

Market Type	Price Difference Percent Mean	Price Difference Percent Median
Monopoly	9.42%	5.59%
Duopoly	11.4%	8.48%
Triopoly	10.3%	11.4%
Competitive	11.3%	11.4%

5. Model Evaluation

5.1 Strengths

In contrast to Peter and Carlton's use of linear models for price prediction, we employ nonlinear supervised learning algorithms to capture the influence of various factors on prices. Nonlinear supervised learning algorithms offer significant advantages over linear regression, particularly in their ability to model complex nonlinear relationships and interaction effects among variables. This adaptability allows for a more accurate representation of intricate market patterns, which is especially valuable in economic applications where price determinants often deviate from linear assumptions. Given the large number of factors influencing prices, assuming a linear relationship is a strong and potentially restrictive assumption. Therefore, the use of nonlinear supervised learning algorithms yields higher predictive accuracy.

In terms of variable design, rather than focusing solely on highly overlapping markets, we broaden our scope to examine price changes across the overall market as well as within different market segments. Given that the airline industry is often characterized by oligopolistic competition, mergers are likely to reinforce oligopoly effects. By focusing on different market types, we aim to provide a more intuitive analysis of the merger's impact on various market structures, thereby offering a more comprehensive basis for assessing whether the merger proposal should be approved.

Additionally, we introduce the number of low-cost carriers (LCCs) as a key variable, as their entry significantly impacts market prices. LCCs increase market competition and exert downward pressure on average prices through their lower fare offerings. Compared to previous studies that overlook this variable, our inclusion of LCC presence enables a more comprehensive analysis of how the composition of airlines within a single market influences pricing.

5.2 Weaknesses

Unlike Peter's approach of selecting mergers with significant pre-merger overlap, our analysis considers all markets. One advantage of focusing on markets with high route overlap prior to the merger is that it captures the intense competition that already exists between the merging

firms. This allows for a more direct measurement of how ownership transfer affects unilateral pricing incentives. In contrast, including all markets may introduce excessive noise and obscure the direct impact of changes in the competitive relationship between merging parties on prices.

Additionally, our study does not incorporate the distinction between nonstop and connecting routes. Carlton's research highlights that mergers tend to have a stronger anti-competitive impact in nonstop markets. By neglecting this market classification, particularly for routes with a high degree of overlap, our analysis may suffer from a higher risk of data bias.

Moreover, our pricing prediction model does not account for changes in macroeconomic conditions. Considering the 2008 financial crisis, the market's demand and supply dynamics were intuitively quite different from those in 2019. As a result, the omission of macroeconomic factors may introduce bias in the price predictions.

Finally, in the process of handling the predictor variables for the forecasting dataset, the approach of simply summing the market shares of the two merging firms has a significant flaw. Post-merger, the restructuring of fixed facilities and the reduction in operational costs may result in a combined market share that exceeds the simple sum of the pre-merger shares. Consequently, this approach introduces a higher level of bias in the prediction of key variables.

6. Conclusion

In the airfare pricing model, market distance, market size, and the presence of low-cost carriers are key determinants. Market distance and market size have a positive impact on prices, reflecting operational costs and market demand, respectively. In contrast, the entry of LCCs exerts a negative influence on prices by intensifying market competition. Regression analysis reveals that the relationship between these explanatory variables and airfare is better captured by a nonlinear model. Consequently, the random forest approach outperforms linear regression models in predictive accuracy.

Post-merger, the average market price increases in the short term, but the extent of this increase depends on the merged airline's market share. For instance, following the merger between Northwest Airlines and Delta Air Lines, the combined market share was significantly lower than the hypothetical scenario of a merger between Delta Air Lines and American Airlines. In the former case, the merger led to cost reductions, enabling the firm to lower prices in some markets and implement modest increases in others to enhance its market competitiveness.

In contrast, a merger between Delta Air Lines and American Airlines would result in a strong oligopoly effect. As one of the "Big Six" legacy carriers, American Airlines consistently ranked among the largest U.S. airlines in terms of passenger traffic and fleet size. A simple aggregation of the two firms' 2019 market shares would yield a combined share of approximately 40%. Such a high concentration would amplify oligopoly power, leading to a substantial increase in market prices.

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