Navigating Economic Shocks: A Data-Driven Study of US Airfares During Times of Crisis

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Abstract

How have recent crises impacted domestic airfares in the United States? This project aims to analyze the effects of the attacks on September 11, 2001, the Great Recession, and the recent COVID-19 pandemic on the US airline industry, focusing on average fares for domestic routes.

Introduction

The U.S. airline industry, integral to both domestic and international connectivity, significantly contributes to economic progress. However, it's notably susceptible to various external influences, including economic fluctuations, political changes, and societal shifts. The repercussions of the 9/11 attacks are a prime example, fundamentally altering operational and security protocols in the industry and leading to a dramatic shift in public perception toward air travel. Following these attacks, the industry experienced a sharp decline in passenger numbers, necessitating substantial capacity reductions and resulting in widespread job losses. The economic downturn during the Great Recession (2007-2009) further highlighted the airline industry's vulnerability, as consumer behavior shifted and spending power decreased. The impact of the COVID-19 pandemic, surpassing previous crises, led to an even more profound disruption, compelling over 140 airlines to slash their operational capacity drastically. This crisis particularly affected long-haul flights, bringing additional challenges to the industry.

In navigating these tumultuous periods, airlines have had to carefully balance new operational measures, such as modifying seating arrangements to ensure passenger safety, which in turn has implications for ticket pricing and overall financial viability. Post-9/11 security enhancements, while crucial for safety, also contributed to a decrease in travel demand due to the inconvenience they posed, thereby extending the industry's recovery period. Looking forward, the industry's recovery from the COVID-19 pandemic is anticipated to be gradual, with traveler safety and health measures taking center stage. How the industry adapts to these ongoing challenges and redefines its strategies will be pivotal in determining its future direction and resilience. In my research, I aim to explore the impacts of these key historical events on domestic

airfares, thereby shedding light on the airline industry's capacity to adapt and respond to significant crises.

Literature Review

The literature on airfare pricing mechanisms is extensive and multifaceted, reflecting the complexity of the airline industry itself. The studies by Sergiu Huma (2015), Junwook Chi and Won W. Koo (2009), and Kurt Van Dender (2007) collectively provide a nuanced examination of the myriad factors that influence airfares. Huma's thesis underscores the disruptive role of low-cost carriers (LCCs) in the market, which typically leads to reduced fares and increased passenger traffic, highlighting the dynamic nature of competition and its effects on pricing.

Chi and Koo's research offers a granular look at airline pricing strategies, revealing that even under similar market conditions, carriers such as American and United adopt different pricing models compared to Delta and Southwest. This suggests that airline-specific strategies, perhaps driven by distinct operational efficiencies or brand positioning, are critical in shaping fare structures.

As far as the research on historical events on the industry, Harumi Ito and Darin Lee wrote a 2005 paper on the impact of the 9/11 attacks. In the paper by Ito and Lee (2005), the authors investigate the impact of the September 11 terrorist attacks on the U.S. airline industry. They acknowledge that the initial panic and fear of flying after September 11 gradually subsided but argue that the airline industry still experienced significant changes in demand and passenger perceptions of risk. The paper highlights a controversy surrounding the long-term effects of September 11 on the airline industry. This controversy arises because weak economic conditions were present both before and after the attacks. To address this issue, the authors conduct an

analysis to separate the macroeconomic effects on airline demand from the direct effects of the terrorist attacks. Additionally, they distinguish between the temporary and ongoing components of the September 11 impact.

Data

I obtained data from two government websites with a rich variety of reliable datasets. The main source of data for this project was sourced from the US Department of Transportation. This was a set of panel data collected between 1996 and Q2 2023, including detailed information from 599,280 total observations of 9,615 unique city-pair markets within the US. The data was aggregated for each city-pair market (values were averaged between the two cities), and the city-pair markets were directionless (without regard to origin and destination). The variables of interest were measured quarterly and include average fare, total passengers, and average market share of the lowest-cost carrier. I created a unique panel identifier variable for the city-pair markets and organized this data such that observations were temporally ordered within each city-pair, helping to analyze the data more effectively.

The use of jet fuel is a significant cost for airlines on any route, so I wanted to include the cost of fuel as I believe it adds another relevant and time-varying dimension to my data. For this purpose, I obtained data from the US Energy Information Administration. This data included the monthly average cost (dollars per gallon) of kerosene-type jet fuel between 1975 and 2022. To make this data useable for my project, I used the monthly data to calculate average quarterly costs in each year before merging it with the airfare data. **Table 1** below shows the summary statistics for the merged jet fuel and airfare dataset. **Figure 1** provides a clear visualization of the

trends in average domestic airfares. **Figure 2** shows passenger trends from the data while **Figure 3** provides a more granular look at the effect of the COVID-19 pandemic on passenger air travel. Finally, **Figure 4** shows fluctuations in the cost of jet fuel since 1996.

Table 1

	Unique (#)	Missing (%)	Mean	SD	Min	Median	Max	
year	28	0	2009.4	7.9	1996.0	2010.0	2023.0	
nsmiles	2392	0	1045.0	586.2	46.0	920.0	2783.0	
passengers	5998	0	180.1	631.3	10.0	33.0	25471.0	
fare	39542	0	234.6	72.2	50.5	231.0	770.6	
lf_ms	9870	0	0.4	0.3	0.0	0.3	1.0	
avgfuel	105	5	1.7	0.9	0.4	1.7	3.6	

Figure 1

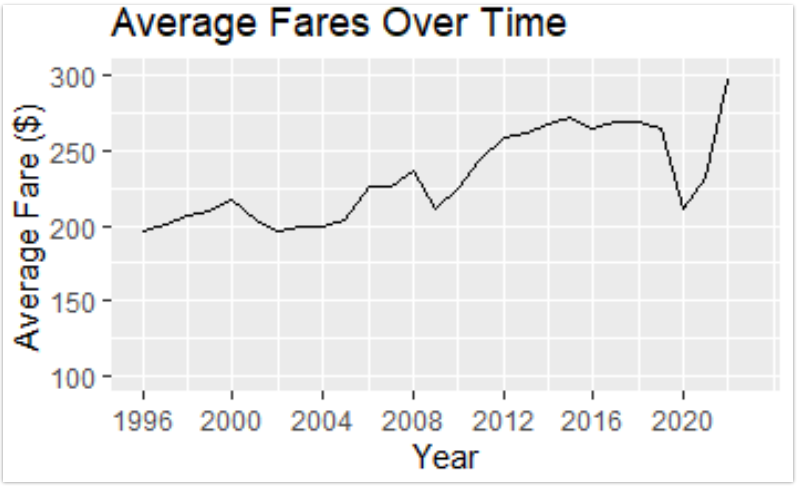


Figure 2

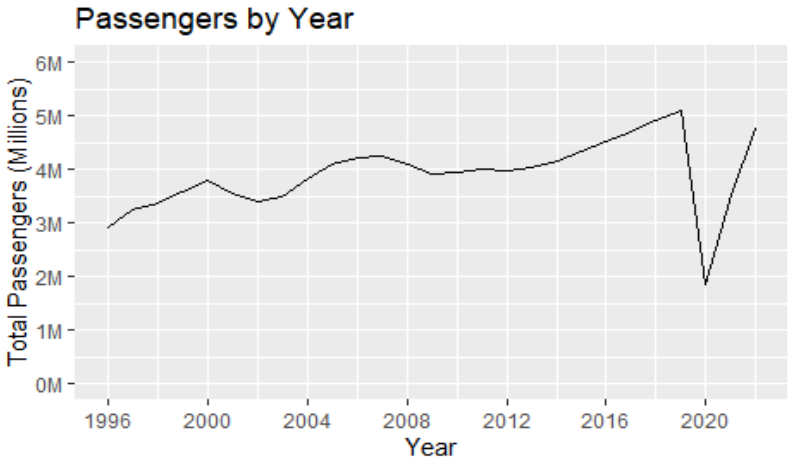


Figure 3

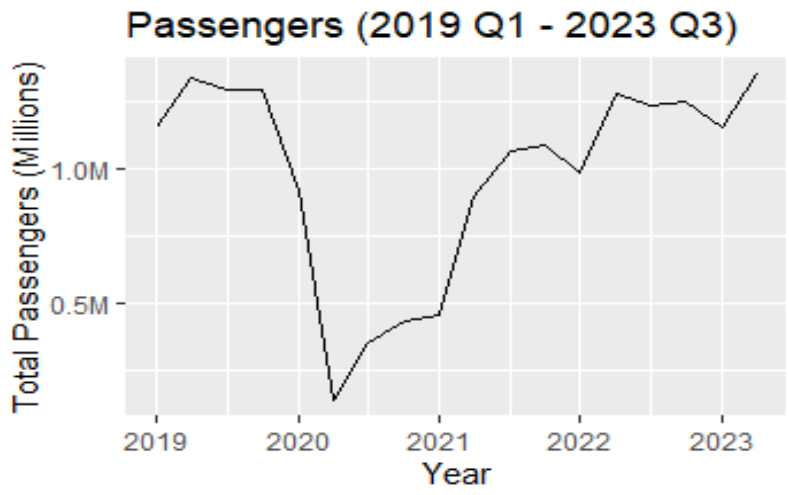
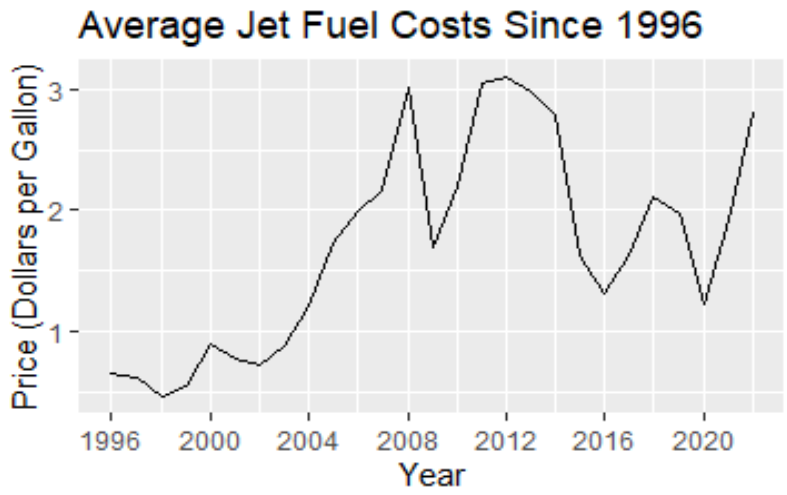


Figure 4



Empirical Methods

Through this project, I aimed to analyze the effects of historical events on average domestic airfares, and I did this via a fixed effects estimation of my panel data, creating time dummies for the periods associated with 9/11, the Great Recession, and the COVID-19 pandemic. I organized the data chronologically within each city-pair market, ensuring a coherent temporal sequence that was crucial for my analysis. This ordering was instrumental in facilitating a detailed examination of trends and patterns over time. My dependent variable, the natural

logarithm of airfares (ln(fare)), was chosen to allow for the interpretation of the coefficients as percentage changes, enhancing the clarity and relevance of my findings.

For my independent variables, I included the logged passengers, the market share of the lowest fare carrier, and logged average fuel costs, along with the aforementioned event dummy variables. The use of fixed effects allowed me to control for unobserved, time-invariant characteristics unique to each city-pair market, isolating the effects of the events and other variables of interest.

Model:

$$\log(\text{fare})_{it} = \beta_1 d911_{it} + \beta_2 grec_{it} + \beta_3 covid_{it} + \beta_4 \log(\text{passengers})_{it} + \beta_5 \text{lfms}_{it} + \beta_6 \log(\text{avgfuel})_{it} + \alpha_i + \varepsilon_{it}$$

Where:

fare = the average overall fare in city-pair market i during time t

d911 = 1 if observation is between Q3 2001 and Q3 2002

grec = 1 if observation is between Q4 2007 and Q2 2009

covid = 1 if observation is between Q1 2020 and Q1 2021

passengers = number of passengers in city-pair market i during time t

lfms = market share of the lowest cost airline in city-pair market i during time t

avgfuel = average cost of jet fuel (dollars per gallon) in time t

α_i = unobserved, time-invariant error

ε_{it} = unobserved error.

Findings

After running the fixed effects regression, I found that each of the three historical events had significant effects on average airfares. On average, domestic fares were 8.8% lower during the two years following the 9/11 attacks. Similarly, average domestic fares were approximately 10% lower during the Great Recession. Average fares during the COVID-19 pandemic were about 17.2% lower, making it the most influential of the three historical events analyzed in this project. To ensure robustness in my findings, I implemented robust standard errors clustered at the city-pair level. This step was crucial in enhancing the reliability and validity of my results, providing more confidence in the conclusions drawn from my analysis. With both the usual, and cluster-robust standard errors, each of the coefficients from the regression were statistically significant at the 0.1% level. The regression produced statistically significant results for the coefficients on the other variables in the model, too. I found that for every percent increase in total passengers in a city-pair market, fares decreased by about 0.17% on average. I also found that for every percent increase in the average cost of fuel, fares increased by about 0.15% on average. **Tables 2 and 3** below show the results from the fixed effects regression (**Table 3** showing the clustered standard errors).

Table 2

	(1)
d9111	−0.088***
	(0.001)
grec1	−0.100***
	(0.001)
covid1	−0.172***
	(0.001)
lpassengers	−0.175***
	(0.001)
lf_ms	−0.012***
	(0.001)
lavgfuel	0.149***
	(0.000)
Num.Obs.	569289
R2	0.286
R2 Adj.	0.274
AIC	−424230.0
BIC	−424151.2
RMSE	0.17

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 3

```
             Estimate Std. Error
d9111       -0.0876554  0.0013936
grec1       -0.1001902  0.0014648
covid1      -0.1715934  0.0026865
lpassengers -0.1745882  0.0026735
lf_ms       -0.0118084  0.0026692
lavgfuel     0.1490085  0.0017010
            t value  Pr(>|t|)
d9111       -62.896 < 2.2e-16 ***
grec1       -68.400 < 2.2e-16 ***
covid1      -63.872 < 2.2e-16 ***
lpassengers -65.303 < 2.2e-16 ***
lf_ms        -4.424 9.691e-06 ***
lavgfuel     87.600 < 2.2e-16 ***
---
signif. codes:
  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’
  0.05 ‘.’ 0.1 ‘ ’ 1
```

Conclusion

The results from this project not only highlight the airline industry's vulnerability to external social, geopolitical, and economic events, it also signals the critical need for resilient business strategies capable of weathering these unexpected crises. Further research in this area can serve as a vital resource for policymakers, providing a data-driven foundation for informed decision-making, especially in times of turmoil. Furthermore, the observed shifts in consumer travel behavior in response to these events open avenues for deeper exploration into how such crises reshape market dynamics and competitive landscapes in the long term.

In conclusion, this study contributes to a further understanding of the airline industry's responsiveness to major geopolitical and economic upheavals. It paves the way for future research endeavors aimed at dissecting the long-term effects of these events, not only on airfare pricing strategies but also on the broader structural evolution of this critical industry.

Limitations

Though my model produced easily interpretable outputs and gave significant estimates, I faced some challenges and concerns worth noting. For one, I faced many challenges finding a granular but understandable dataset. I also had some trouble determining the correct model for this project. I felt that the fixed effects model allowed me to analyze time-varying factors, but it limited my ability to analyze other crucial fare determinants that varied between markets such as distance. Another concern worth noting is the standard errors. Both the normal and clustered standard errors were suspiciously low, raising some concern about the validity of my estimates.

References

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