Impact of Route Efficiency and Stopovers on Airline Fare Pricing

Jingweі Zhao Jyovika Aswale Rimlan Alva

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Executive summary:

This report analyzes airline fare data to uncover key factors influencing ticket prices. Using data from a public Kaggle dataset, we explore how variables like airline, number of stops, and route structure affect fare amounts. Our analysis identifies clear pricing trends based on travel class, airline choice, and route efficiency. These findings can support consumers in making cost-effective travel decisions and provide insight for airline pricing strategies.

Introduction:

Airline fare pricing is shaped by multiple operational and market factors, including route design, efficiency, and the number of stopovers. One key measure, **circuity**, captures how indirect a flight path is relative to the shortest possible route. Another important factor is whether a flight is **nonstop** or involves one or more stopovers. Travelers often perceive nonstop flights as faster and more convenient, which can influence both demand and pricing.

This study focuses on two main research questions: (1) Do routes with higher circuity (i.e., more indirect paths) command a higher fare per mile compared to near-straight flights? (2) Are nonstop flights more expensive than flights with one or more stops? Using a large dataset combining the U.S. Department of Transportation's DB1B and T-100 data, this analysis explores how circuity and stopovers influence airline fares across over 1.5 million samples. By investigating these relationships, the study offers insights relevant to both consumers making travel decisions and airlines designing pricing strategies.

Methodology:

To address our research questions, we analyzed the Airline Market Fare Prediction Data, sourced from the DB1B dataset. The objectives of our analysis were twofold:
1. To determine whether routes with higher circuity—meaning more indirect paths—are associated with higher fare per mile.
2. To compare fare per mile between nonstop flights and those with one or more stops.

For each itinerary, we calculated *fare per mile* by dividing `Average_Fare` by `MktMilesFlown`. Circuity was categorized as either "High Circuity" or "Low Circuity," with the median value of the `Circuity` variable serving as the cutoff. Flight type was classified based on the `Non_Stop` column: itineraries coded as `Non_Stop == 1` were labeled "Nonstop," while all others were categorized as "With Stops."

We summarized the average fare per mile for each combination of circuity group and stop type. The results are presented in Table 1 below.

Table 1: Average fare per mile by circuity group and stop type.

CircuityGroup	StopType	MeanFarePerMile
High	With Stops	0.1734088
Low	Nonstop	0.2463714
Low	With Stops	0.1605630

To further illustrate these relationships, we created a violin plot displaying the distribution of fare per mile across circuity and flight type categories. This visualization is shown in Figure 1.

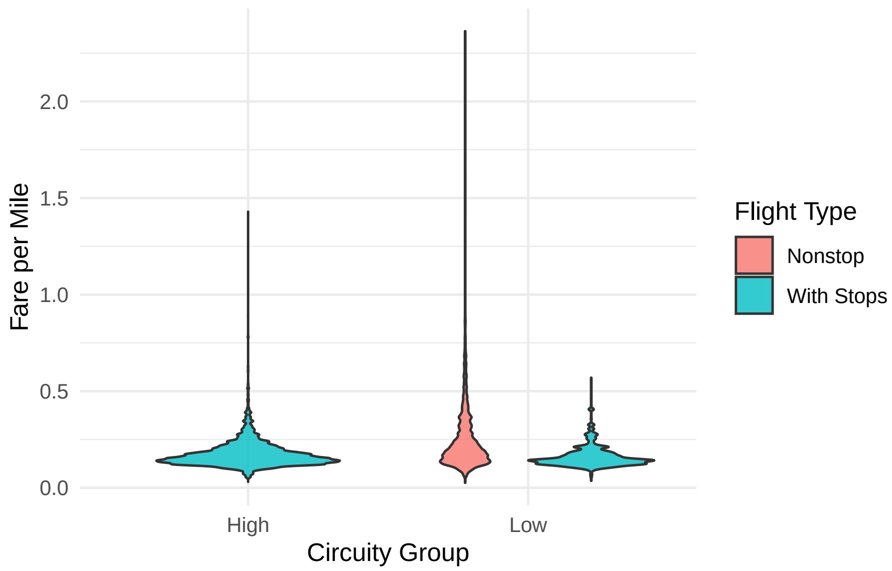

Figure 1: Distribution of fare per mile by circuity group and stop type (Violin Plot)

Results:

Table 2 presents the mean fare per mile by circuity group and flight type. The analysis demonstrates two key findings. First, routes classified as high circuity with stops have a higher average fare per mile (0.173) than low circuity routes with stops (0.161), suggesting that passengers pay a premium for less direct travel. Second, nonstop flights on low circuity routes exhibit the highest fare per mile (0.247), reflecting a significant price premium for direct, efficient service.

Notably, no nonstop flights are observed within the high circuity group, likely because such routes inherently require one or more stops. Overall, these results indicate that both increased circuity and nonstop service are associated with higher fare per mile, while the lowest fares are found on low circuity, multi-stop itineraries. These findings highlight how airlines price both efficiency and convenience in the market.

Table 2: Average fare per mile by circuity group and stop type.

CircuityGroup	StopType	MeanFarePerMile
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Discussion:

These pricing patterns reveal underlying market dynamics that extend beyond simple distance-based fare calculations. The substantial nonstop premium reflects fundamental economic principles of time valuation and consumer segmentation. Business travelers, who typically exhibit lower price elasticity due to employer reimbursement and time constraints, drive demand for premium direct service. This creates opportunities for airlines to implement sophisticated yield management strategies that maximize revenue extraction from heterogeneous passenger populations.

The elevated pricing in high circuity connecting markets suggests structural market imperfections. Geographic constraints may limit competitive entry, while hub-and-spoke network economics can create artificial scarcity in certain city-pair markets. These factors enable pricing power that transcends operational cost differences, indicating that market structure variables (competition intensity, carrier concentration) may be more influential than purely operational metrics.

The contrasting fare distributions between nonstop and connecting flights illuminate different pricing philosophies. Nonstop markets demonstrate characteristics of premium product categories with wide price dispersion reflecting demand-based pricing strategies. Multi-stop markets exhibit commodity-like pricing behavior with narrow distributions suggesting cost-plus approaches focused on operational efficiency rather than demand optimization.

These findings highlight how airlines navigate the tension between network optimization and revenue maximization, using route structure as both an operational constraint and strategic pricing lever.

Conclusion:

This analysis reveals that airline pricing reflects sophisticated market segmentation strategies rather than simple cost-based models. The observed patterns demonstrate how carriers leverage route characteristics to implement differentiated pricing across passenger segments with varying time valuations and price sensitivities.

The findings suggest that market structure factors—including competition intensity and network constraints—play crucial roles in determining fare premiums beyond operational considerations. This indicates that regulatory and competitive dynamics may be as influential as efficiency metrics in shaping airfare structures.

Most significantly, the research demonstrates that airlines successfully monetize convenience through strategic route-pricing combinations, creating sustainable revenue streams from market segmentation while maintaining price-competitive options for cost-sensitive travelers.

Recommendations:

For Strategic Airline Management: * **Portfolio Optimization:** Develop route-pricing matrices that systematically exploit market structure differences, particularly in geographically constrained markets where competition intensity enables premium pricing * **Segmentation Enhancement:** Implement advanced yield management systems that leverage the demonstrated willingness-to-pay differences across passenger segments, especially in nonstop markets showing high fare variability

For Travelers: * **Strategic Route Selection:** Utilize the identified pricing patterns to optimize travel budgets by selecting connecting flights on efficient routes when time flexibility permits * **Market Timing:** Consider that nonstop markets exhibit greater price volatility, suggesting potential savings through strategic booking timing

For Policy and Academic Research: * **Competition Analysis:** Investigate whether observed pricing premiums in high circuity markets reflect natural geographic constraints or anticompetitive market structures requiring regulatory attention * **Methodological Advancement:** Integrate market structure variables (HHI, carrier concentration, LCC presence) with route efficiency metrics to develop more comprehensive fare prediction models * **Consumer Welfare Assessment:** Examine whether current pricing patterns optimize social welfare or primarily benefit airlines through market power exploitation

For Industry Innovation: * **Technology Integration:** Develop dynamic pricing algorithms that better account for the interaction between route efficiency and market competition to optimize revenue across diverse market conditions * **Service Differentiation:** Explore intermediate service categories that capture value between current premium nonstop and budget connecting options

Reference section:

1. *Airline Market Fare Prediction Data.*, from https://www.kaggle.com/datasets/orvile/airline-market-fare-prediction-data

2. *Data Overview: The Origin and Destination Survey (DB1B) – Air Lab.*, from https://airlab.fiu.edu/data-overview-the-origin-and-destination-survey-db1b/

I acknowledge that I have used AI-assisted tools to support my learning process in coding and improving my written English. These tools have helped me understand programming concepts, refine my code, and enhance my academic writing. However, all critical thinking, analysis, and final decisions in this assignment are my own, ensuring that I have fairly and ethically used AI as a learning aid rather than a substitute for my own work.

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