Assessing the Impact of the COVID-19 Pandemic on the Risk-Return Profile of the U.S. Aviation Sector

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Abstract. The COVID-19 pandemic precipitated unparalleled disruptions in the aviation sector, prompting a critical evaluation of the risk-return dynamics within the industry. This investigation focuses on the stock performance of seven prominent U.S. aviation entities, encompassing both manufacturers and airline operators. Employing the Capital Asset Pricing Model (CAPM), the study juxtaposes pre- and post-pandemic financial data to discern the pandemic's fiscal ramifications. The results unearth a dichotomous impact: while manufacturers with defense contracts like Lockheed Martin exhibited stability, commercial airlines such as American Airlines grappled with significant setbacks due to decreased travel. The analysis yields insights into the industry's differential responses to the crisis and highlights the necessity for adaptable strategies in mitigating economic volatilities. This research not only sheds light on the pandemic's immediate effects but also underscores the enduring need for resilience in aviation finance.

Keywords: COVID-19 pandemic, American's Aviation Industry, Risk-Return Analysis, Capital Asset Pricing Model (CAPM), Stock Market Performance.

1. Introduction

This paper studies the impact of COVID-19 on the US aviation industry from the perspective of risk-return trade-off. We focus on manufacturers and airline operators, specifically Boeing (BA), Lockheed Martin (LMT), General Dynamics (GD), Southwest Airlines (LUV), Delta Air Lines (DAL), American Airlines Group (AAL), and JetBlue Airways (JBLU).

Manufacturers such as BA, LMT and GD play a vital role in the design, manufacture and delivery of commercial and military aircraft. They have contributed to technological advancement, job creation and economic growth by providing airline operators with state-of-the-art aircraft. Airlines, on the other hand, are critical to connecting people, goods, and services in the United States and around the globe, providing essential transportation services, stimulating tourism, facilitating business activity, and contributing to the overall economic development of the regions they serve. However, they may be more negatively affected by the COVID-19 pandemic. These airlines have faced a decline in air travel and flight cancellations, they have had to ground large parts of their fleets, cut staff and rethink their operational strategies, so it is clear that the shock of the COVID-19 pandemic has had a significant impact on the entire aviation industry.

2. Literature Review

The existing body of research provides a multi-faceted analysis of the aviation industry's risk-return dynamics, particularly under the stress of external shocks such as the COVID-19 pandemic. This literature review synthesizes the findings from various studies to contextualize the systematic financial risks and responses observed in U.S. aviation entities, both manufacturing and operational.

Lee and Jang [1] (2007) delve into the firm-specific factors shaping systematic risk within the U.S. airline industry, stressing the influence of managerial decisions in operations, investment, and financing on risk metrics. Their work underscores the strategic role executives play in navigating the industry's volatility. In a similar vein, Lee and Hooy [2] (2012) expand this examination to a global context, employing an asset-pricing model to scrutinize the systematic financial risks of airlines

across North America, Europe, and Asia, highlighting the significant role of operating leverage and the impact of earnings growth and firm size on risk exposure.

Tretheway and Markhvida [3] (2014) pivot the focus to the sustainability of the airline industry, comparing its financial returns to other sectors within the aviation value chain. Their analysis reveals a persistent underperformance in airline returns, prompting a discussion on policy interventions for long-term viability.

Amidst the backdrop of the pandemic, Fontanet-Pérez et al. [4] (2022), Atems et al. [5] (2021), and Zheng et al. [6] (2021) collectively examine the repercussions of COVID-19 on airline stock performance. Their investigations demonstrate the immediate and lasting financial impacts of travel disruptions on U.S. airlines, contrasting the robustness of low-cost carriers against the vulnerability of full-service network carriers.

Lastly, Akyildirim [7] (2021) addresses the contagion effects of aviation disasters on engine manufacturers, exploring how such crises extend beyond immediate causality to influence financial stability and market perception, thus affecting the entire aviation ecosystem.

These studies provide a backdrop against which the current investigation is framed, offering a comprehensive understanding of how systemic shocks like the COVID-19 pandemic alter risk-return profiles and the importance of resilient financial strategies within the aviation sector.

3. Empirical analysis

3.1. Model

Here we use the Capital Asset Pricing Model (CAPM), a foundational concept in finance. It is commonly used to determine a theoretically appropriate required rate of return of an asset if the asset is to be added to be well-diversified portfolio. As the idiosyncratic risk can be diversified away, only what is rewarded for bearing the risk is the systematic risk component.

The CAPM's formula is as follows,

$$r_i = r_f + \beta_i(r_m - r_f), \tag{1}$$

Where r_i is the expected return on the asset, r_f is the risk-free rate, β_i is the sensitivity of the expected excess asset returns to the expected excess market returns (commonly known as the beta of the asset), and r_m is the expected return of the market. Clearly, the term $(r_m - r_f)$ represents the market risk premium, *i.e.* the additional expected return of the entire market portfolio above the risk-free rate r_f. The product $\beta_i(r_m - r_f)$, therefore, represents the risk premium of asset i, reflecting the compensation investors require for the risk of the asset relative to that of a risk-free asset.

3.2. Data and Descriptive Analysis

Here we study the continuously compounded returns of NYA, BA, LMT, GD, LUV, DAL, AAL, and JBLU from January 1st, 2013 to 31st December, 2022. Here NYA stands for NYSE composite index and includes all the stocks listed on the New York Stock Exchange (NYSE), and provides a comprehensive measure of their performance. BA, LMT, GD, LUV, DAL, AAL and JBLU are aviation manufacturers/service providers. Their details are as follows.

The Boeing Company is a prominent American aerospace company that specializes in the development, manufacturing, and sale of fixed-wing aircraft, rotorcraft, launch vehicles, missiles, and satellites. As the world's largest manufacturer of spacecraft, Boeing is recognized for its significant role in the aerospace industry. The company expanded its market presence following the acquisition of McDonnell Douglas in 1997, becoming the sole manufacturer of civil aviation wide-body aircraft in the United States. Together with the European company Airbus, Boeing dominates the global market for large-scale civil aviation aircraft. The company's organizational structure is divided into four primary units: Boeing Commercial Airplanes, Boeing Defense Space Security, Boeing Global Services, and Boeing Finance.

Lockheed Martin, a prominent American aerospace manufacturer, was established in 1995 following the merger of Lockheed Corporation and Martin Marietta Corporation. The company has gained global recognition for its expertise in developing and manufacturing military aircraft, which are utilized by numerous countries worldwide. Headquartered in Bethesda, Montgomery County, Maryland, Lockheed Martin stands as the largest defense industry contractor globally, with a significant portion of its revenue generated from contracts with the U.S. Department of Defense, other federal agencies, and international militaries.

General Dynamics Corporation, another major player in the American defense industry, is recognized as the fifth largest defense industry contractor worldwide as of 2020. The company has made notable contributions to the global defense sector through its innovative products and services.

In the aviation industry, Southwest Airlines co (LUV) operates as a leading passenger airline, offering scheduled air transportation services in the United States and internationally. Meanwhile, Delta Airlines serves passengers and cargo on a global scale, with an extensive network that includes major domestic and international markets. The airline's key hubs are strategically located in various cities, including Amsterdam, Atlanta, Cincinnati, Detroit, Memphis, Minneapolis-St. Paul, New York JFK, Paris Charles de Gaulle, Salt Lake City, and Tokyo Narita. These hubs play a crucial role in facilitating the flow of transactional information and connecting regional areas with national and international destinations.

American Airlines Group Inc. is a prominent holding company incorporated in Delaware, and its primary subsidiaries include American Airlines and US Airways Group. The company has successfully positioned itself as a leader in the aviation industry, offering a wide range of services to cater to the diverse needs of its passengers.

Lastly, JetBlue Airways Corporation, a well-known passenger airline, has successfully positioned itself as a "value airline" in the competitive aviation market. The company prides itself on offering superior core products at competitive prices, thereby catering to its diverse customer base and achieving profitable growth.

Table 1 presents the descriptive statistics of the continuously compounded rates of return.

Table 1. Descriptive statistics of the continuously compounded rates of return

	NYA	BA	LMT	GD	LUV	DAL	AAL	JBLU
Max	0.1195	0.3780	0.1379	0.1512	0.2799	0.2728	0.2842	0.2689
Min	-0.1838	-0.6123	-0.1633	-0.1881	-0.2563	-0.4805	-0.4465	-0.5671
SD	0.0401	0.1059	0.0557	0.0599	0.0944	0.1000	0.1236	0.1103
ADF	-4.7186	-4.1461	-5.2007	-4.2589	-5.0031	-4.8176	-4.0272	-4.3695

Note: “Min”, “Max”, “SD” and “DF” stands for the maximum, minimum, standard deviation and Augmented Dickey-Fuller statistic of the series.

From Table 1, it is clear that the most volatile fluctuation of returns is the BA, showing the highest maximum return of 37.80%, and a significant drop to -61.23% at its minimum. AAL, in contrast, has the highest standard deviation, indicating the most variability in its returns. The DF statistics are all negative, and a highly statistically significant, which strongly against a unit root. Therefore, we can safely conduct regression analysis on these continuously compounded rates of return. Furthermore, all ADF tests are significant at 1% significance level, suggesting the continuously compounded rates of return are stationary.

3.3. Regression

In a basic form, the CAPM postulates that the excess return of an asset is linearly related to the excess return of the market portfolio over the risk-free rate. In a real-world context, we need to impose a time series structure to study the relationship overtime. Specifically,

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i\left(r_{m,t} - r_{f,t}\right) + \epsilon_t, \tag{2}$$

Where α is the intercept, β_i is the CAPM beta, ϵ_t is the error term. Clearly, α should be zero theoretically, β_i represents the sensitivity of the asset's excess return to the market's excess return, and ϵ_t is the error term, which ideally should be white noise.

We used the ordinary least squares (OLS) method, which is one of the most widely used techniques in econometrics to estimate the parameter of linear regression model, and under suitably regularity conditions, the OLS estimator is the best linear unbiased estimator (BLUE).

Note that we explored the 13 weekly Treasury bill. However, due to its many missing and the fact daily return is close to zero, we opted for a simplified regression as follows,

$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + \epsilon_t, \tag{3}$$

The results of the Capital Asset Pricing Model (CAPM) regression for different assets are presented in Table 2.

Table 2. Regression Results of CAPM Parameters for Selected U.S. Aviation Industry Stocks

Asset	Term	Estimate	Standard errors	t-statistic
BA	α_i	0.0014	0.0082	0.1699
BA	β_i	1.6606	0.2025	8.2023***
LMT	α_i	0.0138	0.0046	2.996**
LMT	β_i	0.7644	0.1142	6.6958***
GD	α_i	0.0082	0.0044	1.8585*
GD	β_i	0.9983	0.1094	9.1219***
LUV	α_i	0.0062	0.0080	0.7749
LUV	β_i	1.2169	0.1987	6.1228***
DAL	α_i	0.0026	0.0082	0.3174
DAL	β_i	1.3926	0.2038	6.8344***
AAL	α_i	-0.0082	0.0101	-0.8114
AAL	β_i	1.7311	0.2514	6.8861***
JBLU	α_i	-2.00E-04	0.0091	-0.0255
JBLU	β_i	1.5299	0.2253	6.7915***

Note: ***, **, and * correspond to significance at 1%, 5% and 10% significance level.

For Boeing Co. (BA), the estimated alpha (α) is 0.0014 with a standard error of 0.0082, resulting in a t-statistic of 0.1699, and the estimated beta (β) is 1.6606 with a standard error of 0.2025, resulting in a significant t-statistic of 8.2023. Similarly, for Lockheed Martin Corporation (LMT), the estimated alpha is 0.0138 with a standard error of 0.0046, resulting in a significant t-statistic of 2.996, and the estimated beta is 0.7644 with a standard error of 0.1142, resulting in a significant t-statistic of 6.6958. General Dynamics Corporation (GD) has an estimated alpha of 0.0082 with a standard error of 0.0044 and a significant t-statistic of 1.8585, and an estimated beta of 0.9983 with a standard error of 0.1094 and a significant t-statistic of 9.1219. Other assets, such as Southwest Airlines Co. (LUV), Delta Air Lines, Inc. (DAL), American Airlines Group Inc. (AAL), and JetBlue Airways Corporation (JBLU) show similar patterns with significant beta estimates, indicating a strong relationship with the market, and varying levels of alpha, representing the asset-specific returns unexplained by the market. Overall, these results suggest that most of the assets have a significant relationship with the market, as indicated by the beta estimates, while the alpha estimates vary across different assets, indicating differing levels of asset-specific returns.

The BA has a very small positive α_i value of 0.0014. This means, on average, the daily return is 0.0014 above what the CAPM would predict when the market return is zero. LMT has the highest positive α_i of 0.0138. This implies that, on average, LMT performs the market's expectation the most among the given companies. GD, LUV and DAL have positive α_i, but they are lower than LMT's. Noticeably, the estimated α_i for LMT and GD are statistically significant at 5% and 10% significance level, respectively; suggesting their returns significantly deviate from what the CAPM predicts. All other companies do not have statistically significant α_i values. AAL and JBLU have

negative estimated α_i, but they are statistically insignificant. All β_i are statistically significant at 1% level, indicating a strong relationship between the company returns and market returns. Each company has varying degrees of sensitivity to the market, with AAL being the most sensitive (1.7311), and LMT being the least (0.7644).

LMT's small beta and positive alpha in the CAPM results are not surprising. LMT operates in the defense sector, which is characterized by long-term contracts, especially with governments. Such contracts can provide a steady revenue, insulting the company from market fluctuation. The defense industry, in general, is less sensitive to economic downturns than some other sectors. Defense spending tends to be prioritized and remains stable or even increase in uncertain times. Hence the small beta. The LMT's role as a major supplier for may governments and its position as a leader in innovation and technology have contributed to the consistent growth and stability in its return, therefore positive alpha.

AAL, instead, faced profound challenges during the COVID-19 pandemic. With international boarders closing, travel bans and lock-downs, the demand for air travel plummeted, leading to significant financial stresses for AAL as a leader in the civil aviation company, faced massive operational stresses, such as grounded fleets, workshop furloughs, and drastic cuts in flight schedules, these factors likely played into AAL's negative alpha. Similarly, the high beta suggests that AAL's stock is more volatile than the market in general, reflecting the heightened uncertainty, such as travel restrictions, variations in government regulations across countries, and the evolving nature of the COVID-19 pandemic. Furthermore, given AAL specializes in civil aviation, news such as vaccine development, distribution, and potential reopening of borders, lifting of lockdown bans, all these factors would have caused significant stock price swings for AAL, given the company's reliance on these factors for its profitability.

4. Conclusion

This paper has comprehensively analyzed the impact of the COVID-19 pandemic on the U.S. aviation industry through the lens of the risk-return trade-off. The study utilized the Capital Asset Pricing Model (CAPM) to evaluate the returns of seven major U.S. aviation manufacturers and airline operators, providing insights into how the pandemic has altered the risk profiles of these companies.

The empirical findings highlight that companies like Lockheed Martin (LMT) have demonstrated resilience, possibly due to their stable defense contracts, which tend to be less affected by economic cycles. Conversely, American Airlines Group Inc. (AAL) experienced significant financial strain due to its heavy reliance on civil aviation, which was directly impacted by travel restrictions and decreased demand for air travel during the pandemic.

The pandemic's influence on the risk-return profiles of the companies in question was profound. While all the firms showed a statistically significant relationship with market returns, indicated by their beta values, their alpha values varied, revealing differences in individual performance relative to market expectations. AAL's negative alpha value and high beta reflect its vulnerability to pandemic-related disruptions, which is emblematic of the broader challenges faced by civil aviation companies.

In conclusion, the COVID-19 pandemic has not only served as a stress test for the U.S. aviation industry but has also provided a unique opportunity to re-evaluate the industry's risk management strategies and resilience to systemic shocks. It underscores the importance of adaptive business models that can withstand unprecedented global events. For investors, the heightened volatility and the shifting risk-return profiles call for a more dynamic approach to portfolio management within the aviation sector. As the industry navigates through post-pandemic recovery, it will be essential to monitor how these companies adapt and evolve in the face of potential future crises.

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