Assessing Risk in India's Aviation Industry: A Value at Risk Approach

ABSTRACT

This paper examines the financial risks associated with the aviation industry by employing Value-at-Risk (VaR) analysis, using both traditional VaR models and regression techniques to evaluate key risk factors. The VaR model is used to estimate the potential maximum loss within a specified confidence level, providing a probabilistic framework to gauge the extent of possible financial exposure In the context of the aviation sector, characterized by market volatility, fluctuating fuel costs, and economic sensitivity, VaR analysis is particularly relevant for managing financial risks effectively.

This study utilizes two methodologies to estimate potential losses in aviation stocks: VaR, to measure maximum probable losses under normal market conditions, and regression analysis, to assess the impact of various market factors such as fuel prices, exchange rates, and market indices. Findings indicate that only certain factors significantly influence stock returns, providing critical insights for risk management within the sector.

INTRODUCTION

Aviation is a complex industry with inherent risks as it operates within a highly complex and dynamic environment, facing risks that can significantly impact financial performance. In the high-risk environment of the aviation industry, understanding and managing financial risks is critical for sustainable operations. Financial models, particularly the ones designed to quantify risk, play an essential role in identifying, analyzing, and managing these uncertainties. By incorporating a range of risk factors such as market volatility, fluctuating fuel costs, demand variability, and economic sensitivity into predictive financial models, aviation companies are better equipped to gauge the potential financial impact of these risks. Value-at-Risk (VaR) analysis has become a central tool for quantifying potential losses in various industries, including aviation. VaR measures the maximum expected loss over a specific time horizon and confidence level, providing companies with insights into potential downside risk under normal market conditions.

The study of Value at Risk in this context enables firms to assess the likelihood and magnitude of losses tied to these market factors and supports the development of strategic responses and contingency plans, allowing firms to manage volatility effectively and make informed decisions aimed at risk mitigation. Through such financial planning, aviation companies can not only buffer against adverse scenarios but also enhance their resilience to the cyclical and unpredictable nature of the industry. This paper will explore the relevance, methodology, and results of VaR analysis in the aviation industry, utilizing historical data and risk models within asset pricing frameworks. This approach highlights how VaR can serve as a benchmark for financial risk in aviation, integrating market and operational risk considerations crucial for the industry's resilience.

LITERATURE REVIEW

The aviation industry has long been known for its volatility, an issue that has persisted since its early years and continues to affect both developing and developed nations. Numerous studies have explored the growth factors and challenges faced by this sector, with a notable report from **McKinsey & Company** examining the uncertain future of commercial aviation. This report highlights a tidal wave of demand for passenger air travel, which has largely recovered from the COVID-19 pandemic's lows. Meanwhile, OEM (Original Equipment Manufacturer) suppliers and operators are under pressure to deliver, stretching their production capacities and workforce limits. Rising fuel and oil prices have further escalated operating costs, ultimately leading to higher ticket prices for passengers. Beyond economic concerns, the industry is navigating additional disruptions, including travel restrictions, the reopening of borders in China, the war in Ukraine with restricted airspace, labour shortages, and complex supply chain issues. Sustainability, which was previously a secondary concern, has now become an urgent priority, compelling airlines and manufacturers to revisit and revise long-standing practices.

Globally, factors affecting the industry continue to grow in complexity. According to **the Global Outlook for Air Transport – Deep Change report**, climate change alone represents a critical challenge for the global economy, impacting aviation and necessitating a shift away from fossil fuel reliance. Addressing this issue is an overarching priority, with oil and gas prices being a key factor in aviation costs. Conflicts in Europe and the Middle East have contributed to an increase in oil drilling, adding further volatility. Demographic shifts and economic power realignments are also reshaping geopolitical dynamics. In 2023, factors like geopolitical tensions, continued inflation, compromised supply chains, and rising cross-border trade restrictions have significantly impacted global trade in goods.

In India, the **Confederation of Indian Industry** (CII) has identified both opportunities and challenges within the civil aviation sector. While the outlook appears promising, rapid growth has introduced obstacles such as aviation fuel taxation, financing, the Cape Town Convention, and enhancing India's Maintenance, Repair, and Overhaul (MRO) capabilities. High Aviation

Turbine Fuel (ATF) taxes in India present a significant challenge, reducing airlines' financial viability and leading to lower margins, route exits, and fare increases, all of which hinder the sector's growth. Another key issue is India's lack of ratification of the Cape Town Convention, which impacts the leasing environment by increasing risks for creditors in cases of airline insolvency. This scenario results in higher leasing rates for Indian airlines, given creditors' increased risk exposure. As India's aviation industry grows, developing strong MRO capabilities is crucial, especially in component and engine maintenance, which account for a large share of MRO spending. However, with new aircraft models, local MRO infrastructure may take a decade to mature.

Value at Risk (VaR) in Aviation Risk Assessment

This study examines risks in the aviation sector driven by various factors, using the Value at Risk (VaR) framework. VaR, which includes historical VaR, component VaR, and parametric VaR, offers a comprehensive approach to understanding the impact of both economic and non-economic variables on industry risk.

Concept of Value at Risk (VaR)

VaR is widely used in financial sectors to estimate potential losses and has become increasingly relevant in the aviation industry due to its ability to quantify risk in probabilistic terms. Originally developed for banking, VaR was introduced in aviation in the late 1990s, when market volatility began affecting airlines (Jorion, 2006). Various VaR methodologies—such as Historical Simulation, Variance-Covariance, and Monte Carlo Simulation—provide unique approaches to estimating risk based on different assumptions and scenarios. In aviation, VaR offers valuable insights into market volatility and helps assess risks associated with factors like stock returns, revenues, and fuel price fluctuations.

In the Indian context, studies like those by Kumar and Srivastava (2019) underscore VaR's effectiveness in managing currency exchange risk, which is particularly relevant for Indian carriers with significant international operations and high exposure to dollar-denominated fuel expenses. Similarly, Gupta (2021) demonstrated VaR's applicability to stock returns within India's aviation industry, concluding that VaR models provide effective estimates of daily risk exposure but cautioning that relying solely on historical data could be limiting, given the market's volatility.

Types of VaR

- **Historical VaR:** Historical VaR uses historical market data to predict future losses, operating on the assumption that past patterns will continue in the future. This approach is particularly useful in cases where historical data reliably reflects market conditions, although it may struggle to account for sudden or significant shifts in the market.

- **Parametric VaR:** Also known as Variance-Covariance VaR, this approach assumes a normal distribution of returns and estimates risk using the mean and variance of a dataset. While parametric VaR is efficient and widely used, it may not accurately represent markets that exhibit extreme events or skewed distributions, which are often present in the aviation sector.

Regression Techniques in Aviation Risk Modelling

Regression analysis, often used alongside VaR, incorporates additional factors that influence risk, including fuel prices, exchange rates, and GDP growth. This approach allows researchers to determine the relative impact of each variable and improve risk prediction accuracy. Sharma and Verma (2022) applied regression techniques to examine the relationship between oil price volatility and profitability for Indian airlines, revealing a strong correlation between fuel price fluctuations and operational risk. Such models enhance the understanding of how macroeconomic factors influence industry-specific risks.

Combining VaR and Regression for Comprehensive Risk Assessment

Using VaR in combination with regression techniques provides a more comprehensive view of risk by capturing both the probability of extreme losses and the sensitivity to economic factors. In a study focusing on Asian airlines, including Indian carriers, Lee et al. (2020) demonstrated that regression-enhanced VaR models could incorporate fluctuations in exchange rates and fuel prices, improving overall risk predictions. This combined approach allows for simulation of multiple scenarios, assessing how economic changes influence risk exposure and providing a robust risk management framework that goes beyond standalone VaR or regression models.

Empirical Studies on Aviation Risk in India

While research on aviation risk in India is still developing, studies are beginning to shed light on the specific challenges faced by the Indian market. Kaur and Mehta (2023) analyzed the risk exposure of Indian low-cost carriers, utilizing both parametric and non-parametric VaR models to assess potential downside risk of operating margins under different economic scenarios. Their findings underscore the need for adaptable VaR models that account for non-linear relationships, particularly in a volatile market like India. The study also highlighted fuel prices and exchange rates as critical variables affecting the risk profiles of Indian carriers, with regression models further emphasizing these dependencies.

Limitations and Future Directions

Although VaR and regression models are powerful tools for risk assessment, they have limitations, particularly in their ability to capture tail risks and extreme events, which are common in high-volatility sectors like aviation.

Standard VaR models often assume a normal distribution, which may not apply in such cases. Future research could address these limitations by incorporating methods such as Extreme Value Theory (EVT) or Conditional VaR (CVaR), which are better suited for capturing tail risks. In the Indian context, future studies could also benefit from integrating more granular data, including factors like sector-specific inflation and policy shifts, which have significant implications for the aviation industry.

DATA AND METHODOLOGY

Through this study, we aim to provide a detailed analysis of the risks faced by the aviation industry, drawing on the strengths of VaR and regression techniques to capture the full scope of both economic and non-economic influences on the sector's risk profile. This combined framework will help enhance risk management strategies and improve decision-making for stakeholders within the industry.

Considering the research objectives, the researchers have conducted a Value at Risk analysis of the Indian Aviation sector. To meet the objectives, the study focuses on three publicly listed aviation companies' stock prices in the Indian market spanned for the time period 11-11-2015 to 1-11-2024.

1. Jet Airways
2. Interglobe
3. SpiceJet

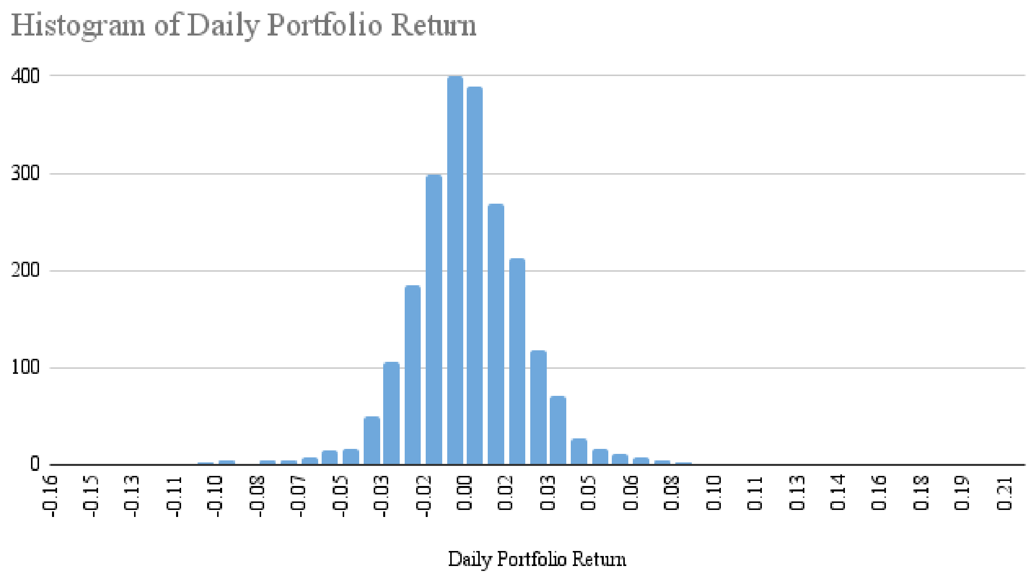
In addition to the VaR analysis, a regression analysis has been performed to identify and quantify the underlying factors influencing the risk associated with these stocks. The key variables considered in the regression model are:

1. Jet Fuel Prices
2. Foreign Exchange rate i.e., USD/INR
3. Bond Yields
4. Broad Index i.e., Nifty 500

Data collected from varied and reputable sources such as Investing.com, among others are compiled into Excel for the purpose of calculating Value at Risk. Furthermore, regression is conducted to evaluate the relationships between these macroeconomic and market factors and their impact on the risk profiles of the selected aviation stocks.

Methodology used to calculate Value at Risk:

1. Stock prices of three publicly listed companies in the Indian market were collected.
2. To calculate the returns, ln(P1/P0) formula was used.
3. Mean, Variance and Standard Deviation of each stock was calculated.
4. Variance- Covariance Matrix, Correlation Matrix were built to understand the relationship amongst the three stocks.
5. Assuming equal weights are given to each of the stocks, the researchers calculated daily portfolio return.
6. Variance- Covariance or Parametric and Historical Value at Risk are calculated at 90%, 95% and 99%.



Variance-Covariance Value At Risk	
Portfolio Return	-0.01%
Portfolio Variance	0.05%
Portfolio Standard Deviation	2.24%
Variance Covariance VaR at 90%	-2.88%
Variance Covariance VaR at 95%	-3.70%
Variance Covariance VaR at 99%	-5.16%

Interpreting the Variance-Covariance VaR Numbers:

1. Variance-Covariance VaR at 90%: There is a 10% chance that the portfolio will lose more than -2.88% of its value over the specified period.
2. Variance-Covariance VaR at 95%: There is a 5% chance that the portfolio will lose more than -3.70% of its value over the specified period.
3. Variance-Covariance VaR at 99%: There is a 1% chance of a loss exceeding -5.16% of its value over the specified period.

In Essence: These Variance Covariance VaR figures provide a probabilistic estimate of potential losses, taking into account the diversification benefits or risks of the portfolio. The variance-covariance method is generally considered more accurate than the historical method, especially for portfolios with many assets and complex relationships between them.

Historical Value At Risk	
Portfolio Return	-0.01%
Portfolio Variance	0.05%
Portfolio Standard Deviation	2.24%
Historical VaR at 90%	-2.45%
Historical VaR at 95%	-3.26%
Historical VaR at 97.5%	-4.16%

Interpreting the Historical VaR Numbers:

1. Historical VaR at 90%: There is a 10% chance that the portfolio will lose more than -2.45% of its value over the specified period.
2. Historical VaR at 95%: There is a 5% chance that the portfolio will lose more than -3.26% of its value over the specified period.
3. Historical VaR at 97.5%: There is a 2.5% chance of a loss exceeding -4.16% of its value over the specified period.
4. Historical VaR at 99%: There is a 1% chance of a loss exceeding -6.13%% of its value over the specified period.

In Essence: These Historical VaR figures provide a probabilistic estimate of potential losses. As the confidence level increases, the VaR value also increases, reflecting the higher potential for significant losses.

Methodology Used for Regression Analysis

1. The dependent variable, i.e. the airline stocks are regressed upon three explanatory variables named above.

2. Following that, a correlation matrix has been plotted as it displays the correlation coefficients between multiple variables in a dataset. Correlation coefficients quantify the strength and direction of the linear relationship between two variables.

Jet Airways

Jet Airways=β0+β1.Jet fuel. +β2.USD/INR+β3.Nifty 500+β4. Bond Returns+ϵ

```
lm(formula = jet_airways ~ jet_fuel + usd_inr + nifty_500 + bond_ret,
    data = reg_1)

Residuals:
     Min       1Q   Median       3Q      Max
-0.46928 -0.11550 -0.04698  0.10528  1.17219

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.22348    0.25287   0.884    0.379
jet_fuel    -0.08456    0.19433  -0.435    0.664
usd_inr      2.36588    1.71649   1.378    0.171
nifty_500    2.51812    0.52599   4.787 5.35e-06 ***
bond_ret    -0.03459    0.03585  -0.965    0.337
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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2301 on 109 degrees of freedom
Multiple R-squared:  0.198,	Adjusted R-squared:  0.1685
F-statistic: 6.726 on 4 and 109 DF,  p-value: 7.081e-05
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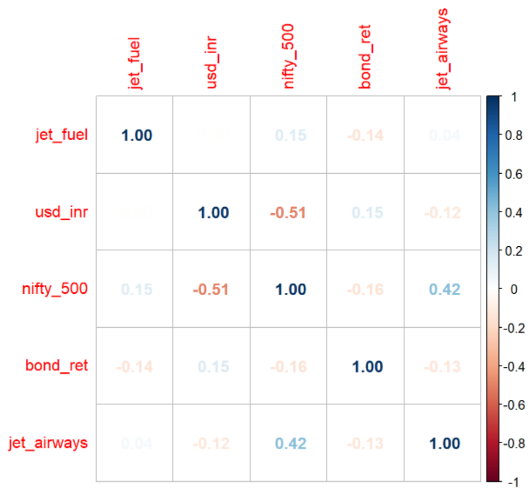

The results indicate that Jet Airways' stock returns were not influenced by factors like jet fuel prices, the USD-INR exchange rate, or bond rates. Instead, a significant positive relationship was found with the Nifty 500 index returns, highlighting the primary dependency of Jet Airways' returns on the broader market index.

Spice Jet

SpiceJet= β0+β1.Jet fuel. +β2.USD/INR+β3.Nifty 500+β4. Bond Returns+ϵ

```
lm(formula = spice_jet ~ jet_fuel + usd_inr + nifty_500 + bond_ret,
    data = reg_2)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.26256 -0.08437 -0.01886  0.06088  0.65630 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) -0.27105    0.16566  -1.636   0.1047    
jet_fuel    -0.12710    0.12731  -0.998   0.3203    
usd_inr     -1.20289    1.12453  -1.070   0.2871    
nifty_500    1.67017    0.34459   4.847 4.19e-06 ***
bond_ret     0.04047    0.02348   1.723   0.0877 .  
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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1508 on 109 degrees of freedom
Multiple R-squared:  0.2724,	Adjusted R-squared:  0.2457 
F-statistic:  10.2 on 4 and 109 DF,  p-value: 4.714e-07
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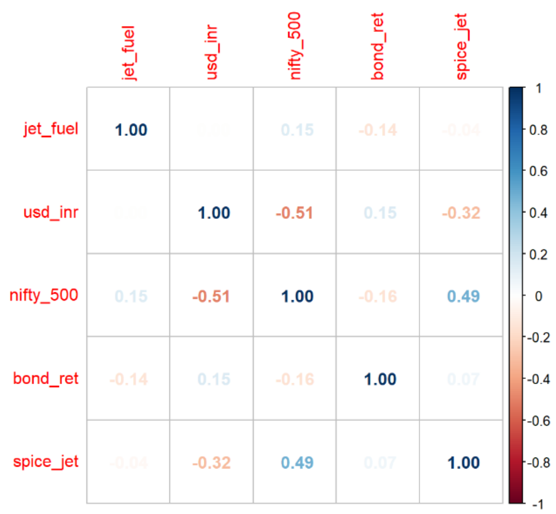

The results suggest that Nifty 500 index returns have a significant positive effect on SpiceJet stock returns at a 0.1% significance level, indicating that SpiceJet returns are positively correlated with overall market performance as captured by Nifty 500. Other factors, including jet fuel prices, USD/INR exchange rate, and bond returns, are statistically insignificant in this model.

Indigo

Indigo=β0+β1.Jet fuel. +β2.USD/INR+β3.Nifty 500+β4.Bond Returns+ϵ

```
lm(formula = indigo ~ jet_fuel + usd_inr + nifty_500 + bond_ret,
    data = reg_3)

Residuals:
      Min        1Q    Median        3Q       Max 
-0.261961 -0.054680  0.007216  0.053485  0.210767 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)  0.0100219  0.1043041   0.096 0.923657    
jet_fuel    -0.0405359  0.0778774  -0.521 0.603920    
usd_inr     -1.6578338  0.6755459  -2.454 0.015947 *  
nifty_500    0.7673223  0.2012272   3.813 0.000244 ***
bond_ret     0.0002534  0.0150107   0.017 0.986569    
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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08605 on 95 degrees of freedom
Multiple R-squared:  0.2987,	Adjusted R-squared:  0.2692 
F-statistic: 10.12 on 4 and 95 DF,  p-value: 7.276e-07
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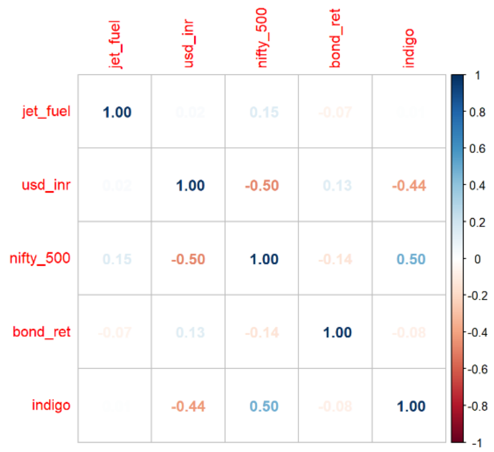

The regression analysis results indicate that exchange rate (USD/INR) and Nifty 500 returns significantly affect Indigo's stock returns, with the USD/INR exchange rate at a 5% significance level and the Nifty 500 returns at a 0.1% significance level. Nifty 500 returns positively impact Indigo's stock returns, whereas the exchange rate impacts it negatively. Other factors (jet fuel and bond returns) are found to be statistically insignificant in this model.

CONCLUSION

This paper explored the application of Value at Risk (VaR) analysis within the aviation industry, focusing on quantifying potential financial losses that aviation companies might face due to market fluctuations and economic volatility. Using historical data from selected Indian aviation stocks, we applied both parametric and non-parametric VaR methodologies. Our methodology incorporated regression analysis to understand the influence of key economic factors, such as jet fuel prices, currency exchange rates, and broader market indices on these companies' risk profiles.

The results demonstrated that market risk, as captured by VaR, is a critical measure for aviation companies, particularly given the industry's sensitivity to external factors like fuel price volatility and currency fluctuations. The findings underscore the importance of VaR as a benchmark for assessing potential downside risk, allowing aviation firms to develop effective risk management strategies. This study highlights how combining VaR analysis with regression techniques can provide a robust framework for understanding and managing the complex risk landscape in aviation, enhancing the industry's resilience in an increasingly volatile market environment.

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