Testing the Efficacy of Bankruptcy Prediction Models : A Study of Jet Airways

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Abstract

Purpose : This study aimed to test the efficacy of four prediction models – the Altman *Z* score model, the Zmijewski model, the Pilarski model, and the Springate model to examine their efficacy in forecasting the downfall of Jet Airways.

Methodology : To assess the financial condition of Jet Airways from 2011–2018, scores of the Altman *Z* score model, Zmijewski model, Pilarski model, and Springate model were calculated. Further, to assess the statistical differences in means, the study used SPSS to conduct one-way ANOVA tests. Post hoc tests were also employed to identify the most accurate model.

Findings : All four models were found to be efficient in predicting the bankruptcy of Jet Airways. According to the one-way ANOVA test findings, the Zmijewski model emerged as the most accurate model (*M* = 2.278); whereas, the Springate model displayed the least predictive accuracy (*M* = –0.103). Post-Hoc Games-Howell test results revealed that the Zmijewski model surpassed other models in predicting insolvency, while the Springate model exhibited the least predictive ability to predict the distress of Jet Airways (2011 – 2018).

Practical Implications: Insights from this study are expected to assist aviation companies in identifying early signs of financial distress. The study will be useful for management to manage financial risks and safeguard long-term sustainability and competitiveness in the industry.

Originality/Value : The results of the study were able to provide an accurate assessment of the financial position of Jet Airways during 2011–2018 and its impending bankruptcy. The idea of using the combination of all four models in the case of Jet Airways is a novel approach.

Keywords : **Jet Airways, bankruptcy, bankruptcy prediction models, forecasting, econometrics, financial management, air transportation**

JEL Classification Codes : G33, G01, E65

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For the past 50 years, Altman (1968), Beaver (1966), and Ohlson (1980) have conducted extensive professional and scientific studies on bankruptcy prediction. Every shareholder is impacted by estimating

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the probability that a company may declare bankruptcy. The study and analysis of bankruptcy prediction has reached the level of a scientific discipline, which has contributed to the development of bankruptcy prediction models as the foundation for long-term viability and corporate growth (Mishraz et al., 2021). A great deal of research is done to create improved models that use both linear and non-linear methodologies to improve the bankruptcy prediction process.

Prediction of financial distress is a crucial exercise, applicable across all sectors. Bankruptcy is a major social and economic problem that impacts all the stakeholders in a company. Forecasting financial difficulties can significantly help reduce losses, mitigate risks, and prevent financial resources from being misallocated (Mishraz et al., 2021). Sarangi et al. (2019) opined that financial forecasting is the process of estimating future information by using available historical financial data. Accurate prediction models can ensure that impromptu protective action can be accommodated if a company is predicted to be headed toward bankruptcy. Financial crisis prediction models are becoming an increasingly important tool for businesses of all sizes to identify early warning indicators.

The air transportation business is a major contributor to worldwide tourism and generates substantial employment opportunities, contributing to worldwide economic development (Fung et al., 2006). As such, the aviation industry is prone to risks like economic boom and recession cycles, oil price changes, exchange rate fluctuations, political uncertainty, etc. A variety of factors, like weather, terrorist attacks, and natural catastrophes, also pose significant challenges to the airline industry, resulting in depleted bottom lines and reduced profitability.

Due to the stiff competition in the Indian airline industry, the potential to make profits is largely restricted, and aviation companies need to resort to innovative strategies to retain customers and maintain profit margins. Such dynamic techniques may increase the likelihood of financial difficulty and insolvency by exposing an aircraft firm to a variety of risks. There are several instances of airlines going bankrupt owing to insolvency throughout the world (Belobaba, 2015). In the Indian context, "Kingfisher Airlines" was unable to pay back its debt, forcing it to suspend operations in 2012. About 2,000 flights were canceled by "Spice Jet" in late 2014 as a result of overwhelming losses. "Air Asia" delayed its extension plans in 2016 owing to the financial crisis. "Air Pegasus" was declared insolvent in 2017. Two more airlines, namely "Air Carnival" and "Air Costa," closed in the same year. Jet Airways is the most recent example of an airline suspending its operations in 2019 owing to financial distress. Jet Airways was rapidly becoming one of the leading airlines in India, with a market share of 27%, as the country's skyline continued to grow. However, despite its optimistic future, the company experienced a decline. What caused this downturn, and could it have been prevented? Was it possible to predict this impending bankruptcy through distress prediction models? This study attempts to answer these questions by exploring distress prediction models that could have forecasted Jet's bankruptcy.

Extant literature on the application of insolvency prediction models in the airline industry is scarce. Most of the distress prediction studies are in the manufacturing industry or banking insolvency prediction. This study, therefore, aims to bridge this gap and contribute to the existing literature by applying the prediction models to one of the prominent companies in the Indian aviation sector. Existing literature abounds with studies on distress prediction; however, most of the studies are limited to applying either one or two models. This study is one of the few that employs four prediction models simultaneously to ascertain the most effective and accurate model among them. Hence, this research examines the effectiveness of bankruptcy prediction models by using Jet Airways as an example from India. The objectives of this study are as follows: First, this study evaluates the performance of four prediction models, namely the Altman *Z*-score model, the Zmijewski model, the Pilarski model, and the Springate model, to determine their applicability in predicting the demise of Jet Airways. Second, this study attempts to identify the most efficient bankruptcy model that predicts distress events with the most accuracy, and finally, this study also identifies the reasons for the failure of Jet Airways.

Literature Review

Bankruptcy models as a field of study have been extensively researched in the existing literature. The strength of a bankruptcy prediction model depends on its capability to predict bankruptcy much before its actual failure. Studies on bankruptcy research have existed for the past six decades. Beaver (1966) employed cashflows through a univariate model and attempted to predict the bankruptcy of 79 firms by examining six financial ratios, namely: profitability (net income plus depreciation and amortization/total liabilities, net income/total assets), long-term solvency (total debt/total assets), and short-term liquidity (net working capital/total assets, current assets/current liabilities, and cash, short-term investments, accounts receivable/operating expenses excluding depreciation and amortization).

Altman (1968) developed the first bankruptcy model by using multiple ratios based on the multiple discriminant analysis (MDA), generally referred to as the *Z*-score model. Altman later replaced the *Z*-score model with the ZETA model (1977). In 1993, the Altman *Z*-score model was changed from a five-variable to a four-variable model known as the Altman *Z*-score model. For non-manufacturing firms, the model is assumed to be more effective. In his doctoral dissertation, Hanson (2003) used this revised Altman *Z*-score model, and this model gave reasonably accurate results by classifying bankrupt service companies to a degree of 92% accuracy in the first year and 69% and 54% accuracy in the second and third years, respectively.

Altman (1968) and Beaver (1966) were the early researchers in bankruptcy prediction. After their contribution, the topic of bankruptcy was studied by many more. The successors have made numerous attempts to validate and improvise existing models. Ohlson (1980) used logistic regression for bankruptcy forecasting. A logit model was developed by Zavgren (1985) that could forecast bankruptcy for up to 5 years. Jones and Hensher (2004) used the mixed logit form, while Gepp and Kumar (2008) combined discriminant and logit analysis to generate a bankruptcy prediction model.

In the 1980s, two discriminatory studies were carried out by Gritta (1983) and Altman and Gritta (1984), especially for the aviation market. For a while, it was thought that, compared to generic models, industry-specific models would possibly offer superior or more precise results. Chow et al. (1991) developed the AIRSCORE model using data from airlines. A design known as the *P*-score for air transport was developed by Pilarski and Dinh (1999). Davalos et al. (1999) created a neural network model for major US airlines, while Gritta et al. (2000) created a neural network model to anticipate financial difficulty for small carriers. Although these models correctly predicted samples' bankruptcy for up to a year, they did not significantly outperform logistic regression or MDA in terms of prediction accuracy (Gudmundsson, 2002). Altman and Gritta (1984) studied the application of prediction models by businesses in countries other than the United States for the first time. Although there were more than ten countries in this study, just one statistical model was used. Numerous studies were conducted earlier to determine the best forecasting model. However, most of the research has been done in developing countries.

The majority of studies carried out in India concentrate on the use of the *Z*-score and modified *Z*-score to select businesses from various industries, such as aviation. Barki and Halageri (2014) used the Altman *Z*-score model to evaluate the financial strength of a subset of Indian textile enterprises. Panigrahi (2019) tried to evaluate the presence of financial distress in the Indian pharmaceutical sector, supported by the Altman *Z*-score on specific firms. Chandra and Awasthi (2019) analyzed insolvency risk in four significant Indian commercial banks using the *Z*-score, while Suriyamurthi and Velavan (2010) ascertained the financial health of EID Parry Sugars Limited company by analyzing data of 10 years from 1998–1999 to 2007–2008 using the *Z*-score. Chatterjee (2018) compared the prediction accuracies of Altman's *Z*-score model and Ohlson's *O*-score model in the prediction of financial distress in Indian large-cap companies. Gupta and Gupta (2023) evaluated the predictive ability of four models: Altman *Z*-score, Altman's emerging market score, Zmijewski, and the KMV model to predict the

bankruptcy prediction of Ruchi Soya Industries Ltd. in the Indian context. Ramesh and Kumar (2018) evaluated the efficacy of asset and debt management ratios as a tool to predict corporate bankruptcy.

A number of researchers have studied the aviation industry in India. After analyzing the Indian aviation market, the authors concluded that demand is expected to be high and that the factors necessary for the industry's growth are comparable (Bhattacharya et al., 2019). The *Z*-score model and its modifications have been the main tools utilized in studies done in the Indian aviation industry. Kulkarni (2018), Kumar and Anand (2013), Pandey and Rathore (2013), and Safiuddin (2017) used the Altman *Z*-score and modified *Z*-score to evaluate the financial health of Kingfisher Airlines. The findings verified the airline's negative returns. Another analysis by Vasantha et al. (2013) explored other variants of the above-mentioned model on selected Indian aviation firms and verified that Kingfisher Airlines may be hit by bankruptcy.

In his research, Upadhyay (2019) concluded that the high operating cost of Jet Airways relative to its competitors prevented it from meeting its short- and long-term debt obligations. A research team led by Rossi et al. (2019) combined evaluations using Altman's *Z*-score, Piotroski's *F*-score, and Beneish's *M*-score to ascertain the financial troubles of Jet Airways. Beneish's *M*-score revealed the lack of management, while Altman's *Z* and *P*-scores in this analysis may point to Jet Airways's impending insolvency. This suggests that the inability of the financial model to function was the cause of the collapse of Jet Airways.

Previous literature indicates Altman and Zmijewski's models were efficient in predicting bankruptcy irrespective of industry. Pilarski's model is especially applicable in the aviation industry, which has the ability not only to alert such companies in time but also to make financial assessments beforehand. The predictive capability of the Springate model can be evaluated through its utilization of MDA to identify four ratios from a pool of 19 commonly used ratios. Many studies compare the accuracies of various financial distress models. One of the studies has employed three models consisting of the Altman *Z*-score, Springate, and Zmijewski models to predict bankruptcy irrespective of any companies (Aviantara, 2021). Another study conducted by Prasetyo et al. (2019) also used the Altman, Springate, and Zmijewski models as tools for prediction analysis of financial distress in Indonesia's Exim Bank study, and the output was compared.

The body of existing research makes clear that, despite the fact that studies on distress prediction are widely available, most of them have used one, two, or, at most, three models. One of the few research that applies four prediction models and also identifies the best successful model is this one. Furthermore, no research on the aviation industry has ever taken into account the four bankruptcy prediction models—Altman, Zmijewski, Pilarski, and Springate models—at the same time in order to forecast the financial difficulties of Jet Airways. Among the first attempts to do so is this study. The study's findings should help aviation businesses avert unanticipated circumstances that could drive them to the brink of bankruptcy owing to internal or external risks and implement remedial actions.

Journey of Jet Airways and Reasons for its Downfall

Jet Airways commenced its journey aiming to be the number one private air carrier in India in the year 1992. Within a short period, Jet amassed a 17.8% market share and was poised to become one of the prominent players, growing by 20% in 1994. Jet needed immense financial backing, and almost 40% of its funding came from foreign investors. However, that did not last very long, as in 1997, the government decided to discontinue foreign direct investment for carriers, and Naresh Goyal, the founder chairman of Jet Airways, was forced to buy back 40% share. In 2001, Jet experienced its first loss due to a rise in taxes, increasing expenditures, and a decrease in demand. In order to obtain additional capital after going public on the Bombay Stock Exchange (BSE) in 2004, Jet diluted 20% of its ownership. Due to shifting government regulations and heightened competition, the aviation sector has become incredibly price-sensitive. In 2006, Jet chose to combine with Sahara Airlines in order to gain

dominance in the Indian market. The benefits of this merger did not materialize because of the inefficiencies of senior management, which could have improved Jet's position in the market. The decline persisted in making Jet Airways's financial strain worse. Finally, in April 2019, it was completely grounded and had to cease its operations. After repeated attempts to salvage itself, Jet Airlines was forced to submit itself to the National Company Law Tribunal (NCLT) and was declared insolvent in 2019. Some prominent reasons for Jet's downfall are enumerated below.

Competition in the Indian Aviation Industry

The Indian aviation market has been extremely price-sensitive, increasing the chances of incurring high losses. The other industry titans were pushed to maintain both low prices (competitive pricing) and high quality because of the growing competition from low-cost carriers such as Indigo and SpiceJet. All the other carriers began matching these costs, even though Jet was having trouble competing with low-cost carriers who weren't sacrificing quality. Ultimately, this choice proved to be highly costly for the business.

Dependency on Loans

A year-on-year increase in fuel prices, loss-making routes, and usage of such wide-body aircraft in place of the B737s played a key role in reducing their operation efficiency and increasing losses. The domestic passenger market share decreased from 22.5% in 2015 to just about 15.5% in 2018, as a result of which the airline was making losses for eight consecutive years (March 2008–March 2015) (Daga & Shah, 2019). The lowering of prices to match competitors such as Indigo and SpiceJet and the industry facing rising fuel prices and increased taxes led to a rise in its spending and created major problems for the former number one private carrier.

Merger with Sahara Airlines

Jet attempted to combine with Sahara Airlines twice, first in January 2006 and then again in April 2007, when it paid ₹ 1,450 crores to extend its operations and access international airspace. The merger with Sahara proved to be overly expensive for Jet Airways due to Sahara's overvaluation. The merger remained unsuccessful for most of the acquisition; Sahara was rebranded as Jet Lite, a low-cost carrier for Jet, and the two continued to operate separately.

Data and Research Methodology

Since Jet Airways was declared bankrupt in 2019, this analysis only takes into account data from the eight years between 2011 and 2018. After 2018, the debt ballooned out of control, cash flows dried up, and revenue fell to zero. For this reason, the data was limited till 2018. To ascertain whether this bankruptcy was imminent, data for this period were collected from secondary sources like the company's annual reports, the National Stock Exchange (NSE), the Directorate General of Civil Aviation (DGCA), Money Control, newspapers, and the RBI website.

The four prediction models used in the study are the Altman *Z*-score, Zmijewski, Pilarski, and Springate. The Altman model has been the most used in bankruptcy prediction studies, irrespective of industry. Zmijewski and Springate models have been used widely in existing studies, with a prediction power of 95.3% and 92.5%, respectively. Pilarski's model used in the case of airline companies has provided better results as compared to other models one-way ANOVA along with the post-hoc Games Howell test are the research methodologies used to

estimate the statistical differences in means using SPSS. Post-hoc tests have also been employed to identify which combination of models has significant means. This study also employs accounting-based ratios under the *Z*-score model. The use of an accounting-based model allows for a higher level of risk-adjusted return on credit activity as compared to a market-based model (Agarwal & Taffler, 2008).

Bankruptcy Prediction Models

Altman Z-Score Model

The Altman model is a combination of various factors that are used to calculate the *Z*-score for a company. The *Z*-score is calculated using a specific formula, as indicated in Table 1.

Table 1. *Altman Z-Score Formula*

$Z = 6.56X1 + 3.26X2 + 6.72X3 + 1.05X4$
$X1$ – Ratio of working capital.
$X2$ – Proportion of retained earnings to total assets.
$X3$ – Ratio of operating profit to total assets.
$X4$ – Ratio of MV of equity to total liabilities of the corporate house.

Source : Altman et al. (1995).

Operating profit has been approximated using earnings before interest and tax (EBIT).

The financial leverage is expressed through this model.

Criteria:

> 2.6	Bankruptcy not likely,
1.1 – 2.6	Gray Area,
< 1.1	Likely to get bankrupt.

The study makes use of the new *Z*-score model, which consists of just four variables. In order to develop the emerging market scoring (EMS) model, Altman made modifications to the original Altman *Z*-score model (Altman et al., 2017). To help standardize the results, a constant term of +3.25 is added to the *Z*-score value (Altman et al., 1998; Altman, 2005; Altman & Hotchkiss, 2005; Badea & Matei, 2016). The model resulted in an accuracy of more than 95% and was able to diagnose corporate bankruptcy two years before actual bankruptcy. A high ratio indicates that the company is willing to take on debt to fund its expansion. If the return on debt generated by a company is lower than the cost of debt financing, it may be compelled to declare bankruptcy.

Zmijewski Model

This model first appeared in 1984. It employs ratio analysis to assess a company's performance, leverage, and liquidity, as indicated in Table 2.

Criteria:

+ve score – Likely to get bankrupt.
–ve score – Not likely to get bankrupt.

Table 2. *Zmijewski Score Formula*

$Z = -4.3 - 4.5X1 + 5.7X2 - 0.004X3$
$X1$ – ROA (Earning after tax/Total asset)
$X2$ – Leverage (Total debt/Total asset)
$X3$ – Current Ratio (Current asset/Current liabilities)

Source : (Januri et al., 2017).

Pilarski Model

This is a logit model evaluating the probability of bankruptcy developed by Pilarski and Dinh (1999). This model was primarily used for assessing the financial condition of major US air carriers and is believed to be giving exceptional outcomes in comparison to other models (Goodfriend et al., 2004). This approach, often known as the *P*-score model, generates a *p*-value, which represents the probability of a company going bankrupt, as indicated in Table 3.The higher the *p*-value, the more the probability of a firm going bankrupt.

Table 3. *Pilarski Score Formula*

$W = -1.98X1 - 4.95X2 - 1.96X3 - 0.14X4 - 2.38X5$
$X1$ – Operating revenues/Total assets
$X2$ – Retained earnings/Total assets
$X3$ – Equity/Total debt
$X4$ – Liquid assets/Short-term debt
$X5$ – Earnings before interest and taxes/Operating revenues

Source : (Gratzer & Stiefel, 2008).

Springate Model

Gordon L. V. Springate introduced this model in 1978. The Springate model is a ratio model that is used to assess a firm's financial health. It employs the MDA methods to choose four of the 19 most commonly used financial ratios (Januri et al., 2017), as indicated in Table 4. Companies with a *Z*-value < 0.862 are classified as "failed" in this model.

Table 4. *Springate Score Formula*

$Z = 1.03X1 + 3.07X2 + 0.66X3 + 0.4X4$
$X1$ – Working Capital/Total Assets
$X2$ – Net profit before interest and taxes/Total assets
$X3$ – Net profit before taxes/Current liabilities
$X4$ – Sales/Total assets

Source : (Januri et al., 2017).

Hypotheses

↳ **H01 :** There is no significant difference in means amongst bankruptcy prediction outcomes derived from Altman, Zmijewski, Pilarski, and Springate's models from 2011– 2018.

↳ **Ha1 :** There is a significant difference in means amongst bankruptcy prediction outcomes derived from Altman, Zmijewski, Pilarski, and Springate's models from 2011–2018.

↳ **H02 :** There is no significant difference in means between bankruptcy prediction outcomes derived from the Altman model and Zmijewski model from 2011–2018.

↳ **Ha2 :** There is a significant difference in means between bankruptcy prediction outcomes derived from the Altman model and Zmijewski model from 2011– 2018.

↳ **H03 :** There is no significant difference in means between bankruptcy prediction outcomes derived from the Altman model and the Pilarski model from 2011–2018.

↳ **Ha3 :** There is a significant difference in means between bankruptcy prediction outcomes derived from the Altman model and the Pilarski model from 2011–2018.

↳ **H04 :** There is no significant difference in means between bankruptcy prediction outcomes derived from the Altman model and the Springate model from 2011–2018.

↳ **Ha4 :** There is a significant difference in means between bankruptcy prediction outcomes derived from the Altman model and the Springate model from 2011–2018.

↳ **H05 :** There is no significant difference in means between bankruptcy prediction outcomes derived from the Zmijewski model and Pilarski model from 2011–2018.

↳ **Ha5 :** There is a significant difference in means between bankruptcy prediction outcomes derived from the Zmijewski model and the Pilarski model from 2011–2018.

↳ **H06 :** There is no significant difference in means between bankruptcy prediction outcomes derived from the Zmijewski model and the Springate model from 2011–2018.

↳ **Ha6 :** There is a significant difference in means between bankruptcy prediction outcomes derived from the Zmijewski model and the Springate model from 2011–2018.

↳ **H07 :** There is no significant difference in means between bankruptcy prediction outcomes derived from the Pilarski model and the Springate model from 2011–2018.

↳ **Ha7 :** There is a significant difference in means between bankruptcy prediction outcomes derived from the Pilarski model and the Springate model from 2011–2018.

Analysis and Results

Altman Z-Score Model

Table 5 highlights the financial and operational performance of Jet Airways. The *Z*-score was highest in 2011, indicating that Jet Airways was not bankrupt then. From 2012 onwards, the company slipped into the grey zone and finally became bankrupt, as per the *Z*-scores. Therefore, it can be concluded that Jet Airways ceased to be a viable company right from 2012. The efficiency, profitability, and leverage ratios portray the negative performance of the firm. The company was never even near the grey area of the scores (1.1–2.6); rather falls in the threshold of likely to get bankrupt. Note that a constant term of +3.25 was added to calculate the *Z*-score (Agarwal & Taffler, 2008).

Table 5. *Altman Z-Score Model*

Year	2011	2012	2013	2014	2015	2016	2017	2018
Altman *Z*-score	3.667	1.254	0.894	–1.426	–0.892	0.859	1.042	–2.106

Zmijewski Model

This model specifies the likelihood of potential bankruptcy of a company indicated by a positive number and a negative number for unlikeliness. Table 6 shows the *Z*-values obtained through this model are positive for every year, signifying the company was subjected to potential bankruptcy regularly, eventually becoming bankrupt in 2018.

Pilarski Model

From Table 7, it appears that Jet Airways was always on the verge of bankruptcy, which increased through the years (higher *p*-values indicate increased bankruptcy possibility). The financial distress of Jet had significantly risen after the merger with Sahara, and its liabilities had increased multi-fold, resulting in a further downfall of its already diminishing EBIT. Jet's operating asset turnover ratio, i.e., the efficiency ratio, was almost stagnant every time; its operating revenue was surely increasing, but its total assets were decreasing. The major outcome of this model is the fact that Jet was facing major difficulties in meeting its short-term debt obligations as well.

Springate Model

According to the Springate model, if the *Z*-value is lesser than 0.862, the company is deemed to be bankrupt. As per Table 8, the *Z*-values of Jet Airways have been consistently below 0.862 from 2011 onwards, implying that the company was in the hazard of becoming financially distressed and possibly inching toward bankruptcy.

Table 6. *Zmijewski Model*

Year	2011	2012	2013	2014	2015	2016	2017	2018
Zmijewski *Z*-score	0.26	1.347	1.619	2.988	3.068	2.019	1.945	4.976

Table 7. *Pilarski Model*

Year	2011	2012	2013	2014	2015	2016	2017	2018
Pilarski *P*-score	0.685	0.819	0.837	0.945	0.967	0.931	0.954	0.983

Table 8. *Springate Model*

Year	2011	2012	2013	2014	2015	2016	2017	2018
Springate *Z*-score	0.328	–0.183	–0.006	-0.792	-0.339	–0.398	0.457	0.106

Table 9. ***Descriptive Analysis of Altman, Zmijewski, Pilarski, and Springate Models***

Models	Altman		Zmijewski		Pilarski		Springate	
Year	*Z*-score	Prediction	*Z*-score	Prediction	*P*-value	Prediction	*Z*-score	Prediction
2011	3.667	Non-Bankrupt	0.26	Likely Bankrupt	0.685	Distress	0.328	Bankrupt
2012	1.254	Non-Bankrupt	1.347	Likely Bankrupt	0.819	Distress	–0.183	Bankrupt
2013	0.894	Bankrupt	1.619	Likely Bankrupt	0.837	Distress	–0.006	Bankrupt
2014	–1.426	Bankrupt	2.988	Likely Bankrupt	0.945	Distress	–0.792	Bankrupt
2015	–0.892	Bankrupt	3.068	Likely Bankrupt	0.967	Distress	–0.339	Bankrupt
2016	0.859	Bankrupt	2.019	Likely Bankrupt	0.931	Distress	–0.398	Bankrupt
2017	1.042	Bankrupt	1.945	Likely Bankrupt	0.954	Distress	0.457	Bankrupt
2018	–2.106	Bankrupt	4.976	Likely Bankrupt	0.983	Distress	0.106	Bankrupt

The Altman model's conclusions indicate that Jet Airways's financial situation from 2011 to 2018 can be classified as "Distress," as indicated by the grouping criteria in Table 9. According to Zmijewski's model results, Jet Airways exhibited a positive score throughout, signifying "likely to get bankrupt" or "Potential Distress" criteria. The results show that Jet Airways has always had a higher chance of going bankrupt based on the Pilarski model. Finally, according to the Springate model, since the *Z*-value was less than 0.862, Jet Airways was deemed to be bankrupt right from 2011 to 2018 and hence categorized as a "Potential Distress"/bankrupt firm.

Results of One-Way ANOVA Test with SPSS

Using SPSS, a one-way ANOVA test was conducted to find out statistical differences in means and identify the most accurate model for bankruptcy prediction.

The Zmijewski model has the highest predictive accuracy (M = 2.278) among the four models, whereas Springate has the lowest predictive accuracy (M = –0.103), according to the averages in Table 10. Table 11 displays the ANOVA test results.

Table 10. ***Descriptive Results***

Model	*N*-Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Error	Std. Deviation Statistic
Altman *Z*-Score	8 (2011–2018)	–2.106	3.667	0.412	0.649	1.834
Zmijewski Score	8 (2011–2018)	0.260	4.976	2.278	0.499	1.412
Pilarski Score	8 (2011–2018)	0.685	0.983	0.890	0.036	0.102
Springate Score	8 (2011–2018)	–0.792	0.457	–0.103	–0.103	0.410

Table 11. ***ANOVA Test Results***

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	28.253	3	9.418	6.359	0.002
Within Groups	41.467	28	1.481		
Total	69.720	31			

The ANOVA table (Table 11) shows the value of *F* as 6.359, with the output *p*-value of 0.002. Since the *p*-value of 0.002 is <0.05, it is concluded that there are statistically significant differences between the means of the Altman, Springate, Pilarski, and Zmijewski models as a predictive measure of financial distress in the case of Jet Airways from 2011 to 2018. Further, to identify in which pair of means the difference is significant, a post-hoc test is required. Hence, Ha1 is accepted.

Post-Hoc Test

This study uses the Games-Howell test in SPSS for the post-hoc analysis. As indicated in Table 12, the Games-Howell post-hoc test reveals the following:

- H02 is accepted ($p = 0.132$), and it is inferred that there is no significant difference between the bankruptcy prediction results of the "Altman model" and the "Zmijewski model" for Jet Airways (2011–2018), and Ha2 stands rejected.
- H03 is accepted ($p = 0.879$), and it is inferred that there is no significant difference between the bankruptcy prediction results of the Altman model and the Pilarski model for Jet Airways (2011–2018), and Ha3 stands rejected.
- H04 is accepted ($p = 0.864$), and it is inferred that there is no significant difference between the bankruptcy prediction results of the Altman model and the Springate model for Jet Airways (2011–2018), and Ha4 stands rejected.
- H05 is accepted ($p = 0.099$), and it is inferred that there is no significant difference between the bankruptcy prediction results of the Zmijewski model and the Pilarski model for Jet Airways (2011–2018), and Ha5 stands rejected.

Table 12. ***Results of Post-Hoc Games-Howell Test in Multiple Comparisons***

(*I*) Models	(*J*) Models	Mean Difference (*I–J*)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Altman	Zmijewski	–2.000	0.847	0.132	–4.473	0.472
	Pilarski	–0.479	0.650	0.879	–2.625	1.668
	Springate	0.515	0.665	0.864	–1.632	2.662
Zmijewski	Altman	2.001	0.847	0.132	–.472	4.473
	Pilarski	1.522	0.547	0.099	–0.284	3.327
	Springate	2.515*	0.564	0.009	0.707	4.314
Pilarski	Altman	0.479	0.650	0.879	–1.668	2.625
	Zmijewski	–1.522	0.547	0.099	–3.327	0.284
	Springate	0.994*	0.149	0.001	0.513	1.474
Springate	Altman	–0.515	0.665	0.864	–2.662	1.633
	Zmijewski	–2.515*	0.564	0.009	–4.324	–0.707
	Pilarski	–0.994*	0.149	0.001	–1.474	–0.513

Note. *The mean difference is significant at the 0.05 level.

↳ H06 is rejected ($p = 0.009$) at a 95% confidence interval, and it is inferred that there is a significant difference between bankruptcy prediction results of the Zmijewski model and the Springate model for Jet Airways (2011–2018), and Ha6 stands rejected.

↳ H07 is rejected ($p = 0.001$) at a 95% confidence interval, and it is inferred that there is a significant difference between the bankruptcy prediction results of the Pilarski model and the Springate model for Jet Airways (2011–2018), and Ha7 stands rejected.

Conclusion

The primary objective of this study is to analyze the efficacy of the financial distress models by studying Jet Airways. Though all four models have accurately predicted the downfall of Jet Airways, the Zmijewski model has emerged to be the most preferred and Springate, the least accurate. The outcomes of the several models accurately show and characterize the financial status of Jet Airways. As of 2015, Jet Airways is facing extreme financial strain and a high danger of going bankrupt, according to all four models. Ultimately, as of April 2019, Jet Airways has not operated. Based on the ANOVA results conducted using SPSS, it is evident that there is a significant difference in the means of the Altman, Springate, Pilarski, and Zmijewski models across the years 2011 to 2018. To further establish whether these differences are significant within the combination of models, the post-hoc Games-Howell was conducted.

The post-hoc Games-Howell test results explain that :

↳ In the Altman model hypothesis, it is inferred that there is no significant difference between the means in the case of the other three models.

↳ In the case of the Zmijewski model hypothesis, there is a significant difference between the mean of the Zmijewski and Springate models.

↳ In the case of the Pilarski model hypothesis, there is a significant difference between the mean of the Pilarski and Springate models.

↳ In the Springate model hypothesis, there is a significant difference in the means of Springate, with Zmijewski and Pilarski models, respectively, as mentioned above.

The research comes to the following conclusions using descriptive statistics, ANOVA test, and post-hoc Games-Howell test:

↳ The predictive accuracy of Zmijewski's model in assessing financial distress exceeds that of Pilarski, Altman, and Springate's models.

↳ Pilarski's model exhibits superior accuracy as a predictive tool for financial distress when compared to the Altman model.

↳ The Springate model has been identified as the least predictive measure of financial distress in the case of Jet Airways from 2011 to 2018.

Managerial and Theoretical Implications

It is expected that the results of this study will be beneficial to managers and owners in making timely decisions to avert unfavorable insolvency situations. The findings of the study can benefit aviation companies by applying

forecasting tools to predict bankruptcy, enabling them to take prompt action in time. This study is novel since it has employed four bankruptcy prediction models that predict the bankruptcy of Jet Airways. All four models have proven to establish its impending bankruptcy. While existing literature has used Altman models in its research, this study scores over others by using the new Altman *Z*-score model, which is 95% more accurate. Moreover, the study has also used an accounting-based model that gives a higher level of risk-adjusted return (Agarwal & Taffler, 2008), focusing on the intrinsic valuation while providing insights into a company's fundamental financial health.

Limitations of the Study and Scope for Further Research

The aviation industry is the exclusive subject of this study. Since this particular model combination is optimized for the airline business, the findings may not generalize to other industries. Although it might not be a very good forecast for other businesses, the current analysis might be valuable to the aviation industry. Using the findings of this study as a guide, future research examining the solvency situation of aviation sector businesses can employ different machine-learning approaches and a larger sample size.

Authors' Contribution

Study conception and design: Dr. Deepika Dhingra; data collection: Dr. Deepika Dhingra; Analysis and interpretation of results: Dr. Shruti Ashok and Seema Sharma; Draft manuscript preparation: Dr. Shruti Ashok & Seema Sharma. All authors reviewed the results and approved the final version of the manuscript.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

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