

Improving the F-Score Model for Financial Risk Analysis in the Pharmaceutical Industry

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Abstract. The Z-Score model and F-Score model were applied to analyze the financial risk assessment of Chinese pharmaceutical enterprises, and the relationships and differences between the two models were compared. Based on the analysis of the evaluation results of the two models, factors specific to the development of the pharmaceutical industry and industry policies were considered and incorporated into the assessment indicators. The F-Score model was improved by adding two financial indicators, namely net profit growth rate and asset cash return rate. The improved model has more comprehensive financial indicators, more objective evaluation results, a more accurate F2 value, and a more stable trend change.

Keywords: Financial Risk Analysis; F-Score Model; Pharmaceutical Industry; Digital Healthcare.

1. Introduction

Global digital healthcare is developing rapidly, with the industry exhibiting a variety of trends. Industry services are increasingly moving towards personalization and intelligence, and the market for telemedicine is also expanding rapidly [1]. The iterative evolution of big data in the digital age has brought many new opportunities for enterprises [2,3]. This paper analyses the financial risk issues of RK Pharmaceutical Company in the context of digitalization to gain a deeper understanding of corporate financial risk management theory and improve corresponding financial risk response and prevention measures. Altman[4] was the first to use a multivariate Z-Score model in evaluating corporate financial risk, using Z-value grading to determine the likelihood of financial risk occurring. Zhou Shouhua[5] proposed the F-Score model, which is based on the Z-Score model but incorporates cash flow indicators to address the Z-Score model's shortcomings in predicting corporate financial risk, enabling more accurate assessment of corporate financial risk. Wang Yuanzhuo[6] and other scholars argue that chemical companies in the new economic landscape need to establish diversified financing channels and prioritise financial management to alleviate cost pressures. Zhang Hao[7] and An Suxia[8] suggest fully leveraging 'Internet+' to establish a big data financial risk control system. By comprehensively integrating financial and business data, the system breaks down barriers between corporate departments, enabling automatic data collection and intelligent analysis to achieve business-finance integration and reduce financial risks. Li Jingming[9] found through tests on corporate heterogeneity that digital transformation can effectively reduce financial risks for both state-owned and private enterprises.

2. RK Pharmaceutical Financial Risk Analysis

2.1 Z-Score Model

The Z-Score model[4] is a corporate financial crisis early warning model based on multiple discriminant analysis. It quantifies corporate bankruptcy risk through a linear combination of key financial indicators and has become a classic tool in the field of financial risk analysis. The model selects five-dimensional indicators: working capital/total assets (X1), retained earnings/ total assets (X2), EBIT/total assets (X3), market value of shareholders' equity/book value of total liabilities

(X4), and sales revenue/total assets (X5) to construct the discriminant function $Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 1.0X5$. Based on empirical thresholds, a Z value above 2.675 indicates that the company is in a financially secure zone, a value below 1.81 suggests a significant risk of bankruptcy, and values between the two fall into a warning zone.

2.1.1 Financial Risk Analysis Based on Z-Score Model

Table 1. Financial Risk Analysis of RK Pharmaceutical using Z-Score Model

Year	X1	X2	X3	X4	X5	Z
2017	0.31	0.33	0.08	0.45	0.86	2.23
2018	0.51	0.16	0.08	0.36	0.87	2.17
2019	0.22	0.06	0.01	0.52	1.09	1.78
2020	0.19	0.07	0.04	0.38	0.87	1.55
2021	0.16	0.09	0.03	0.36	0.80	1.43
2022	0.02	0.02	-0.08	0.49	0.67	0.77
2023	0.05	0.03	-0.01	0.44	0.48	0.87
2024	0.07	0.03	0.01	0.32	0.50	0.85

Table 3. Financial Risk Analysis of RK Pharmaceutical 's F-Score Model

Year	X1	X2	X3'	X4	X5'	F1
2017	0.31	0.33	0.1440	0.45	0.0935	0.560045
2018	0.51	0.16	0.0968	0.36	0.0841	0.654604
2019	0.22	0.06	0.0151	0.52	0.0349	0.138979
2020	0.19	0.07	0.0712	0.38	0.0664	0.226944
2021	0.16	0.09	0.0727	0.36	0.0634	0.197846
2022	0.02	0.02	-0.0732	0.49	-0.0317	-0.293744
2023	0.05	0.03	0.0593	0.44	0.0476	0.034321
2024	0.0717	0.0277	0.0046	0.3167	0.0108	-0.069427

Data source: Compiled based on the annual reports of RK Medicine from 2017 to 2024. (similarly hereinafter)

As shown in Table 1, RK Pharmaceutical 's Z-score has been declining year by year, indicating severe financial risks.

2.1.2 Comprehensive Evaluation of Financial Risk Based on the Z-Score Model

A comprehensive analysis of RK Pharmaceutical's financial data from 2017 to 2024 using the Z-Score model reveals that its financial risk has been escalating in an increasingly severe systemic manner. Based on the dynamic changes in Z-values, RK Pharmaceutical was still in the warning zone in 2017 and 2018, but over the next six years, the overall value declined steadily from 1.78 to 0.85, remaining below the bankruptcy warning threshold of 1.81. In 2022, it even dropped to a historical low of 0.77, indicating that the company has been in a high-risk range for an extended period. This trend suggests that although RK Pharmaceutical has been advancing its digital transformation, the imbalance between high short-term investments and low returns has led to a continuous deterioration in its financial structure. The risks have expanded from mere liquidity shortages to encompass interconnected crises across multiple dimensions, including profitability, market confidence, and asset efficiency.

2.2 F-Score Model

The F-Score model [5] predicts a company's financial risk by using five financial ratios and generating a total discrimination score through weighted aggregation. It improves on the X3 and X5

parameters in the Z-Score model, while the other three-dimensional parameters remain unchanged, as shown in Table 2. For the sake of distinction, the new parameters are represented by X3' and X5'.

Table 2. Relationship between Parameters of F-Score Model and Z-Score Model

Independent Variable	Accounting Elements	Calculation	Notes
X ₁	Working capital / Total assets	(Ending current assets - Ending current liabilities) / Ending total assets	Consistent with the Z
X ₂	Retained earnings / Total assets	(Undistributed profits + retained earnings) / Total assets at the end of the period	Consistent with the Z
X ₃ '	EBIT/Average total liabilities	(After-tax net income + depreciation) / (Beginning liabilities + ending liabilities) / 2	
X ₄	Market value of shareholders' equity / Book value of total liabilities	(End-of-period market price per share × total share capital) / (Beginning-of-period liabilities + end-of-period liabilities) / 2	Consistent with the Z
X ₅ '	(Net income + interest + depreciation)/average assets	(Net profit + interest + depreciation) / (Beginning assets + ending assets) / 2	

Its expression formula is: $F1 = -0.1774 + 1.1091X_1 + 0.1704X_2 + 1.9271X_3' + 0.0302X_4 + 0.4961X_5'$

According to the results of big data statistics, when the F1 value is higher than 0.0274, it is considered that the company's financial condition is good and the financial risk is low. When it is lower than 0.0274, it is considered that the company is facing bankruptcy risk. When the F1 value is within the range of 0.0274 ± 0.0775 , i.e., $[-0.0501, 0.1049]$, the company's financial condition is uncertain, and there may be significant prediction errors.

As shown in Table 3, RK Pharmaceutical's F1 values for 2017-2021 were all more than 0.0274 and greater than 0.1049, indicating a strong financial position. In 2022 and 2024, F1 levels were both less than -0.0501, suggesting financial risk. In 2023, the F1 number was greater than 0.0274 but less than 0.1049, indicating financial uncertainty (which is improving).

Although the two models' findings diverge greatly, they have little comparative usefulness despite displaying comparable patterns in the evolution of financial position over time. In the F-Score model, X5 shows how well a firm can create cash flow from its overall assets, whereas X3 reflects the cash flow dimension, which gauges a company's ability to repay debt. The F-Score model can therefore more precisely forecast if a firm is experiencing a financial crisis than the Z-Score model. More pertinent and useful, the F-Score model is also based on statistical analysis of large data from many Chinese listed businesses.

2.3 F-Score Improvement Model

The F-Score model does not take into account the differences in financial indicators across industries or the impact of specific contexts on financial indicators [10]. With the implementation of policies such as the “two-invoice system” “zero markup,” and centralized bulk procurement of pharmaceuticals, the profit margins of pharmaceutical companies have narrowed [11]. It is necessary to incorporate industry policies and specific factors related to pharmaceutical company development into the evaluation metrics, two indicators: corporate development capability and cash flow. Based on big data statistics from the pharmaceutical industry, the accounting elements involved are shown in Table 4, with corresponding X6 and X7 values as shown in Table 5.

Table 4. Specific Indicators for the Pharmaceutical Industry

Indicators	Development capacity	Cash flow
Variable	X6	X7
Accounting Elements	NPRG	Return on cash on assets
Calculation	(Net profit of this year - net profit of last year)/Net profit of last year	Net cash flow from operating activities/total assets at the end of the period

Table 5. Values of RK pharmaceutical parameters X6 and X7 for the Period 2017 - 2024

Year	Current Net Profit	Last Net Profit	X 6	Operating Cash Inflow	Operating Cash Outflow	Net Cash Flow	Total Assets	X7
2017	13.685	6.7510	1.0271	241.0	265.00	-24.0	270.0	-0.0889
2018	12.674	13.685	-0.0739	381.0	383.00	-2.00	349.0	-0.0057
2019	-4.3500	12.674	-1.3432	405.0	384.00	21.00	325.0	0.0646
2020	6.2540	-4.3500	2.4377	333.0	328.00	5.00	321.0	0.0156
2021	3.8200	6.2540	-0.3892	258.0	253.00	5.00	264.0	0.0189
2022	-17.387	3.8200	-5.5516	153.0	148.00	5.00	183.0	0.0273
2023	0.3197	-17.387	1.0184	92.51	91.68	0.83	167.0	0.0049
2024	0.4102	0.3197	0.2831	95.95	94.35	1.60	160.0	0.0100

Improvement of the F-Score Model: $F2 = -0.1774 + 1.1091X1 + 0.1704X2 + 1.9271X3' + 0.0302X4 + 0.4961X5' + 0.0671X6 + 0.0373X7$

Table 6. Financial Risk Analysis Table of RK Medicine's F-Score Improvement Model

Year	X1	X2	X3'	X4	X5'	X6	X7	F2
2017	0.31	0.33	0.11	0.45	0.06	1.0271	-0.0889	0.62565
2018	0.51	0.16	0.08	0.36	0.07	-0.0739	-0.0057	0.64943
2019	0.22	0.06	0.02	0.52	0.04	-1.3432	0.0646	0.05126
2020	0.19	0.07	0.07	0.38	0.07	2.4377	0.0156	0.39110
2021	0.16	0.09	0.08	0.36	0.07	-0.3892	0.0189	0.17244
2022	0.02	0.02	-0.09	0.49	-0.04	-5.5516	0.0273	-0.66524
2023	0.05	0.03	0.06	0.44	0.05	1.0184	0.0049	0.10284
2024	0.07	0.03	0.0048	0.32	0.01	0.2831	0.0100	-0.05006

As shown in Table 6, the F2 value for 2019 was 0.05126, indicating a change in financial status from good to uncertain. According to the annual report, the net profit growth rate for 2019 was -1.3432, with an actual net profit of -435 million, resulting in no profit. This has impacted the company's development capabilities. Compared to the original model's F value of 0.138979, the F2 value is more sensitive and accurate. In 2024, the F2 value was -0.05006, and the financial status changed from improving to risky. Compared to the F value, which predicts financial risk status, the F2 value shows a more stable trend change.

3. Financial Risk Management Recommendations

3.1 Reasonably Plan the Financing Structure

In the critical financing process, RK Pharmaceutical should prudently and reasonably determine the financing scale and term based on its actual operational status and long-term development strategy. The financing structure should be optimized to achieve a balance between equity financing and debt financing, controlling the proportion between the two to prevent excessive reliance on debt financing from leading to high debt repayment pressure.

3.2 Optimize Investment Decisions

During the investment decision-making process, RK Pharmaceutical should establish a comprehensive and scientific investment evaluation system. It should conduct in-depth research on the market prospects of investment projects, thoroughly understand the competitive landscape of the industry, and pay attention to potential risks. By utilizing financial indicators such as net present value and internal rate of return for quantitative analysis, it can prevent blind investments. The company should also reasonably plan its investment portfolio to diversify investment risks.

3.3 Strengthening Working Capital Management

In terms of working capital management, RK Pharmaceutical should optimize inventory management, establish a scientific inventory control system, and classify inventory using methods

such as categorization to reduce inventory buildup and lower inventory holding costs. Additionally, the company should strengthen accounts receivable management, establish reasonable credit policies, and conduct strict customer credit assessments.

3.4 Eepen Digital Transformation

In the context of digital transformation, RK Pharmaceutical should increase investment in digital technology, develop an intelligent financial risk warning system, and use big data analysis to monitor financial and business data in real time, promptly identify potential financial risks, and issue corresponding warning signals. Digital technology should be utilized to achieve automation and standardization of financial processes, thereby reducing errors caused by human operations.

4. Summary

A systematic identification and evaluation of RK Pharmaceutical's financial risks was conducted, with quantitative research based on the Z-Score model, F-Score model, and improved F-Score model. The overall results of the three models were consistent, indicating that RK Pharmaceutical's financial risks are generally increasing. In the Z-Score model, the Z-value has been declining annually, indicating severe financial risks for RK Pharmaceutical. In the F-Score model, the financial evaluation was stable for the first five years but showed a declining trend, with the past three years indicating a state of risk or uncertainty. In the improved F-Score model, which incorporates development capabilities and cash flow indicators into the evaluation criteria, the trend in financial evaluations is more stable. In response to the aforementioned risks, four optimization pathways are proposed: optimizing investment decisions and financing structures to enhance risk management capabilities, strengthening working capital management to improve capital utilization efficiency, deepening digital transformation, and building an intelligent financial early warning system. These recommendations can help RK Pharmaceutical balance innovation investment with financial stability, enhance risk resilience, and provide sustainable financial and operational support for digital transformation.

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