



The Impact of Systematic Financial Fraud on Corporate Financial Health and the Effectiveness of Risk Quantification Models: Evidence from Luckin Coffee

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Abstract. The 2020 revelation of Luckin Coffee's systematic financial fraud, involving RMB 2.2 billion in fabricated sales, triggered a global credibility crisis for U.S.-listed Chinese firms. This scandal exposed vulnerabilities in traditional financial risk models to detect complex, large-scale manipulations. This study examines Luckin Coffee's financial data (2019–2022) to evaluate how systematic fraud impacts corporate financial health and assess the effectiveness of risk quantification models (Altman Z-score and Beneish M-Score) in identifying fraud signals. Through ratio analysis and financial statement deconstruction, key metrics—including revenue growth rate, gross profit margin, cash flow patterns, and leverage ratios—were analyzed alongside Altman Z-score Model and Beneish M-Score models. During the fraud period (2019), manipulated metrics created artificial financial stability. The Z-score (1.67) falsely placed Luckin in the “grey zone,” while the M-Score (-0.379) crossed the manipulation threshold (-1.78). Post-fraud restructuring (2021–2022) demonstrated authentic recovery, with Z-scores rising to 6.73 and M-Scores stabilizing below -1.78. The study concludes that integrating non-financial indicators (e.g., store traffic anomalies, user retention rates) with revised model thresholds is essential for timely fraud detection in high-growth, subsidy-driven business models.

Keywords: Luckin Coffee, financial fraud, Altman Z - score, Beneish M-Score

1 Introduction

Luckin Coffee emerged in 2018 as the "Chinese Starbucks," Expanding rapidly through aggressive marketing strategy and store expansion. However, in April 2020, the company admitted to fabricating financial data from Q2 to Q4 2019, inflating revenue by ¥2.2 billion (40% of reported revenue). The fraud included falsified order volumes, fabricated bank transactions, and exaggerated franchisee income. Luckin's stock price plummeted by 75.57%, leading to delisting from NASDAQ (June 2020), a \$180 million SEC fine (December 2020), and a 175 million investor lawsuit settlement (2021). This event caused a credibility crisis for U.S.-listed Chinese firms, exposing other Chinese companies to short-seller attacks.

This paper takes the financial fraud incident of Luckin Coffee from 2019 to 2022 as the research object. By deconstructing the abnormal signals in its financial statements and combining risk quantification models (such as the Altman Z - score and Beneish M-Score), it analyzes the impact of financial fraud on the financial health of the enterprise and explores the effectiveness of risk early - warning models in identifying systematic financial fraud.

This study employs a combined approach of ratio analysis and financial statement analysis to systematically evaluate the financial health of Luckin Coffee and detect fraud indicators. These methodologies focus on key financial ratios and analytical models to quantify risks and assess the effectiveness of early warning systems.

The research finds that during the fraud period, Luckin covered up its operating losses by inflating revenues and marketing costs. The traditional risk models lagged in warning about its financial risks. Therefore, it is necessary to combine non - financial indicators (such as store growth rate and user retention rate) to improve the sensitivity of the models.

2 Method

The method selected for this research is ratio analysis and financial statement analysis. The following ratios and models will be calculated and interpreted.

2.1 Revenue Growth Rate

Reflects the growth rate of a company's operating revenue over a specific period. A higher value generally indicates faster growth in sales scale and stronger market competitiveness. A negative value may signal business contraction or declining market demand. (Equation (1)).

$$\text{Revenue Growth Rate} = \frac{\text{Current Period Revenue} - \text{Previous Period Revenue}}{|\text{Previous Period Revenue}|} \times 100\% \quad (1)$$

2.2 Cash Flow Growth Rate

This ratio indicates the percentage change in a company's operating cash flow over time. Higher: Generally positive, as it suggests stronger operational performance, efficient cash management, or successful growth strategies. Lower/Negative: May signal reduced liquidity, declining sales, or unsustainable spending. (Equation (2)).

$$\text{Cash Flow Growth Rate} = \frac{\text{Current Period Cash Flow} - \text{Previous Period Cash Flow}}{|\text{Previous Period Cash Flow}|} \times 100\% \quad (2)$$

2.3 Gross Profit Margin

The ratio of gross profit to sales revenue, reflecting the profit margin after deducting direct production costs. High values indicate strong pricing power or cost control

(e.g., >20% is considered healthy); low values suggest thin profit margins. (Equation (3))

$$\text{Gross Profit Margin} = \frac{\text{Revenue} - \text{COGS}}{\text{Revenue}} \times 100\% \quad (3)$$

2.4 Sales Expense Ratio

It shows the percentage of revenue spent on sales-related costs (e.g., advertising, salaries). Lower: More efficient cost management. Higher: May indicate aggressive growth efforts or inefficiencies. (Equation (4))

$$\text{Sales Expense Ratio} = \frac{\text{Total Sales Expenses}}{\text{Net Sales}} \times 100\% \quad (4)$$

2.5 Current Ratio

This metric assesses short-term solvency (i.e., ability to cover short-term obligations with liquid assets). A ratio significantly above 2 may indicate underutilized assets or inefficient capital allocation. A ratio below 1 suggests heightened liquidity risks and repayment pressure. The commonly accepted optimal range is 1.5–2. (Equation (5))

$$\text{Current Ratio} = \frac{\text{Current Asset}}{\text{Current Liabilities}} \quad (5)$$

2.6 Debt-to-Asset Ratio

The proportion of total liabilities to total assets, reflecting financial leverage and solvency. A ratio <60% is considered safe for most industries. Too high (>80%) implies high default risk; too low may indicate underutilization of leverage for growth. (Equation (6)).

$$\text{Debt-to-Asset Ratio} = \frac{\text{Total Liabilities}}{\text{Total Assets}} \times 100\% \quad (6)$$

2.7 Altman Z-score Model

A predictive model using weighted financial ratios to estimate bankruptcy risk. A higher Z-score indicates stronger financial health, while a lower score implies a greater likelihood of financial distress. The calculation of the Altman Z-score Model is presented in the following formula [1]. (Equation (7)).

$$Z = 1.2X_1 + 1.3X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \quad (7)$$

The variables mentioned in this equation are calculated using the following formulas. (Equation (8) to Equation (12)).

$$X_1 = \frac{\text{Working Capital}}{\text{Total Assets}} \quad (8)$$

$$X_2 = \frac{\text{Returned} \frac{\text{Earnings}}{\text{Accumulated}} \text{Deficits}}{\text{Total Assets}} \quad (9)$$

$$X_3 = \frac{\text{EBIT}}{\text{Total Assets}} \quad (10)$$

$$X_4 = \frac{\text{Market Value of Equity}}{\text{Total Liabilities}} \quad (11)$$

$$X_5 = \frac{\text{Sales Revenue}}{\text{Total Assets}} \quad (12)$$

Critical Values are explained below.

$Z > 2.99$: Safe Zone

$1.81 < Z < 2.99$: Grey Zone

$Z < 1.81$: Risk Zone

2.8 Beneish M-Score

The Beneish M-Score is a financial fraud prediction model proposed in 1999 by Professor Michele Beneish from Indiana University, USA. It constructs a regression equation using eight financial indicators, such as the current ratio and receivables turnover ratio, to calculate the probability of a company manipulating earnings. A score greater than -1.78 indicates potential financial fraud risk, and this model is widely used to detect financial statement manipulation in corporate reporting [2]. (Equation (13)).

$$\text{M Score} = -4.84 + 0.92 \times \text{DSRI} + 0.528 \times \text{GMI} + 0.404 \times \text{AQI} + 0.892 \times \text{SGI} + 0.115 \times \text{DEPI} - 0.172 \times \text{SGAI} + 4.679 \times \text{TATA} - 0.327 \times \text{LVGI} \quad (13)$$

The variables mentioned in this equation are calculated using the following formulas. (Equation (14) to (20)).

$$\text{DSRI} = \frac{\text{Recivables/Sales}}{\text{Recivables}_{t-1}/\text{Sales}_{t-1}} \quad (14)$$

$$\text{GMI} = \frac{\text{Gross margin}_{t-1}}{\text{Gross margin}} \quad (15)$$

$$\text{AQI} = \frac{\left(1 - \frac{\text{PPE} + \text{CA}}{\text{TA}}\right)}{\left(1 - \frac{\text{PPE}_{t-1} + \text{CA}_{t-1}}{\text{TA}_{t-1}}\right)} \quad (16)$$

$$\text{SGI} = \frac{\text{Sales}}{\text{Sales}_{t-1}} \quad (17)$$

$$\text{DEPI} = \frac{\text{Depreciation Rate}_{t-1}}{\text{Depreciation Rate}} \quad (18)$$

$$\text{SGAI} = \frac{\frac{\text{SG\&A Expense}}{\text{Sales}}}{\frac{\text{SG\&A Expense}_{t-1}}{\text{Sales}_{t-1}}} \quad (19)$$

$$LVGI = \frac{\frac{\text{Total Debt}}{\text{Total Assets}}}{\frac{\text{Total Debt}_{t-1}}{\text{Total Assets}_{t-1}}} \quad (20)$$

3 Analysis and Discussion

3.1 Company Background Introduction

Luckin Coffee was established in 2017 as an emerging coffee brand in China. The initial design of its business model focused on price-sensitive consumers as the core target, forming differentiated competition with traditional premium coffee brand Starbucks through a "low price + high cost-performance" product positioning [3]. Additionally, it attracted tea beverage-preferring customer groups by launching Luckin Tea. Such innovative tea products had not yet appeared in stores of coffee brands like Starbucks and Costa. This product strategy both satisfied segmented market demands and avoided direct competition with traditional coffee giants [4].

At the operational level, Luckin Coffee adopted a social fission mechanism to achieve user base growth, specifically using a discount acquisition method through users spontaneously sharing coupon links to expand the customer base in a marginal cost-decreasing form [5]. It also built a user profiling system relying on big data technology, implementing pricing and product recommendations based on consumption time periods and category preferences [6]. Notably, during its startup phase, Luckin rapidly penetrated the market by providing high subsidies to dealers (cumulative investment exceeding 1 billion RMB) [7]. Promotional strategies like free first orders and large discount coupons significantly increased market share but also caused persistently high per-order loss rates in the early stage.

In May 2019, Luckin Coffee went public on NASDAQ, setting a global record for the fastest IPO. Under the combined effects of optimistic capital market expectations and internal performance pressures, Luckin's management began systematically fabricating financial data. In January 2020, Muddy Waters Research released an anonymous report (prepared by a third-party investigation agency), revealing through technical means including satellite imagery, store traffic monitoring, and order data scraping that Luckin had inflated order volumes by 69% and 88% respectively in the third and fourth quarters of 2019, involving approximately 2.2 billion RMB in fraudulent transactions [6]. Although Luckin denied the allegations when the report was published, it admitted to financial fraud in April of the same year, triggering violent fluctuations in the capital market. Luckin's stock price plummeted over 80% that day, and it delisted from NASDAQ on June 29, 2020.

This incident created a chain reaction, with Luckin facing an \$180 million fine from the U.S. Securities and Exchange Commission (SEC) for false statements. Luckin's financial fraud not only negatively impacted other Chinese companies listed in the U.S., but also imposed greater costs on other Chinese companies hoping to list in the U.S. in the future [8]. Its technology-driven "internet coffee" concept had previously obtained premium valuation in capital markets, but the subsidy-dependent growth model proved

unsustainable, ultimately leading to the eruption of systemic risks from financial data manipulation.

3.2 Ratio Analysis

The financial data used in the following ratio analysis calculations are all derived from Luckin Coffee's financial reports from 2019 to 2022 [9-12].

Revenue Growth Rate.

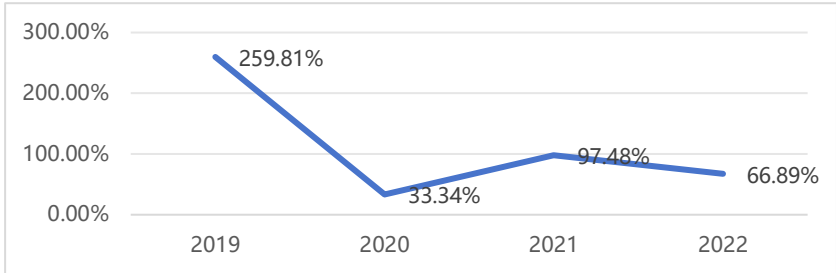


Fig. 1. Revenue growth rate

The revenue growth rate of Luckin Coffee from 2019 to 2022 is shown in the graph above. The extraordinarily high growth in 2019, reaching 259.81%, was driven by fabricated revenues as disclosed in the fraud. (Fig. 1) The obvious contradiction between the inflated revenue growth and the negative operating cash flow (amounting to -RMB 3,160 million in 2019) emphasized the core fraud mechanism, which was to falsify orders and transactions so as to overstate income and cover up the underlying operational losses. After the fraud was exposed in 2020, the revenue growth returned to rational levels. From 2021 to 2022, in order to contain losses, stores were closed, and with focus on products like "Luckin Tea", a sustainable growth rate of 60% to 100% was achieved, demonstrating the outcomes of business restructuring.

Cash Flow Growth Rate.

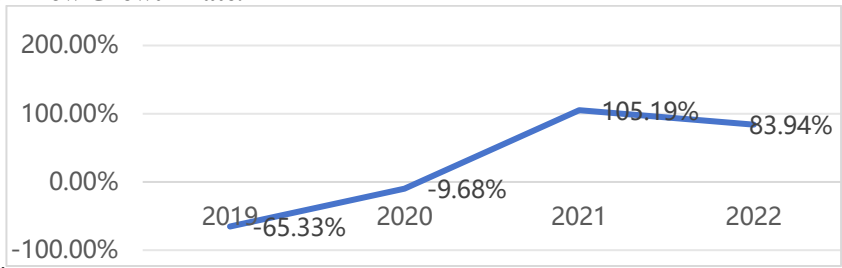


Fig. 2. Cash flow growth rate

The cash flow growth rate of Luckin Coffee from 2019 to 2022 is shown in the graph above. (Fig. 2) In 2019, the cash flow growth rate signified an increase in the year-over-year loss magnitude, with operating cash flow remaining deeply negative at -RMB 2,167 million, which indicated deteriorating operations and increased cash usage. From 2020 to 2022, the cash flow growth rates were -9.68%, 105.19%, and 83.94%, showing volatility and recovery. Cash flow growth turned positive in 2021–2022, and operating cash flow itself improved from -RMB 2,377 million in 2020 to positive RMB 123 million in 2021, indicating improved liquidity through cost-cutting, not revenue manipulation.

Gross Profit Margin.

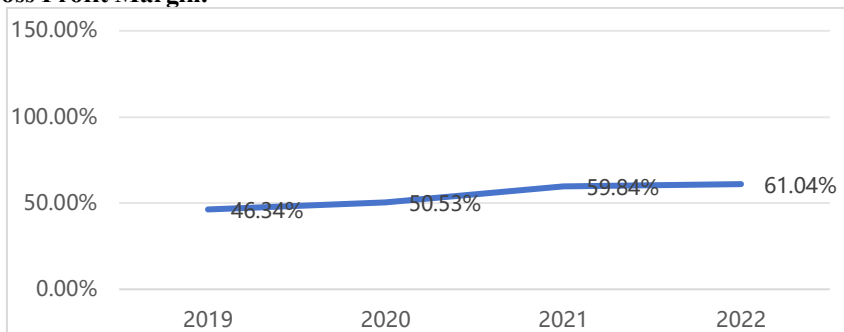


Fig. 3. Gross Profit Margin

The gross profit margin of Luckin Coffee from 2019 to 2022 is shown in the graph above. (Fig. 3) In 2019, Luckin Coffee's gross profit margin was 46.34%. While the company inflated both revenue and expenses, the abnormally high gross profit margin—driven by artificially suppressed material costs—remained a red flag. After the fraud was exposed, the gross margin rose to over 60%, primarily due to business restructuring (e.g., shifting to higher-margin drinks like Coconut Latte), economies of scale and the closure of underperforming stores.

Sales Expense Ratio.

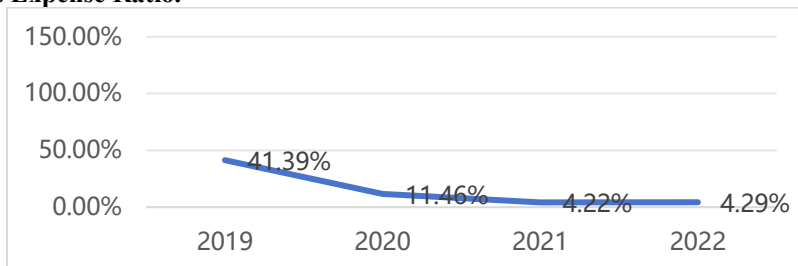


Fig. 4. Sales Expense Ratio

The sales expense ratio of Luckin Coffee from 2019 to 2022 is shown in the graph above. (Fig. 4) The sharp drop from 2019 to 2020 reflected a strategic shift away from aggressive subsidies and marketing (a key fraud-era tactic to drive fake sales). The stable, low ratio in 2021–2022 indicated sustainable cost management, aligning with the company’s focus on organic growth rather than unsustainable promotional spending.

Current Ratio.

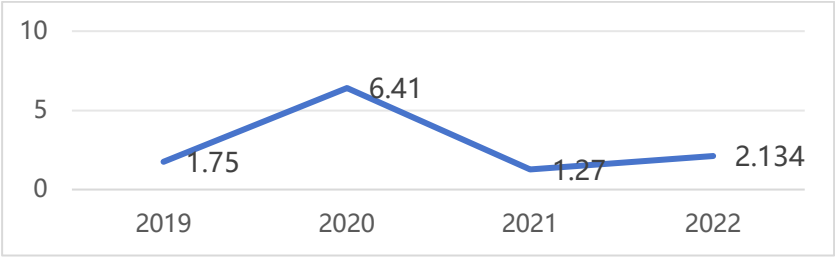


Fig. 5. Current ratio

The current ratio of Luckin Coffee from 2019 to 2022 is shown in the graph above. (Fig. 5) In 2020, the spike to 6.41 was misleading as total liabilities increased from RMB 4,620 million in 2019 to RMB 6,597 million, driven by fraud-related regulatory penalties and liabilities; during 2021–2022, the decline to 1.27–2.13 indicated balanced short-term liquidity, reflecting healthier working capital management post-restructuring.

Debt-to-Asset Ratio.

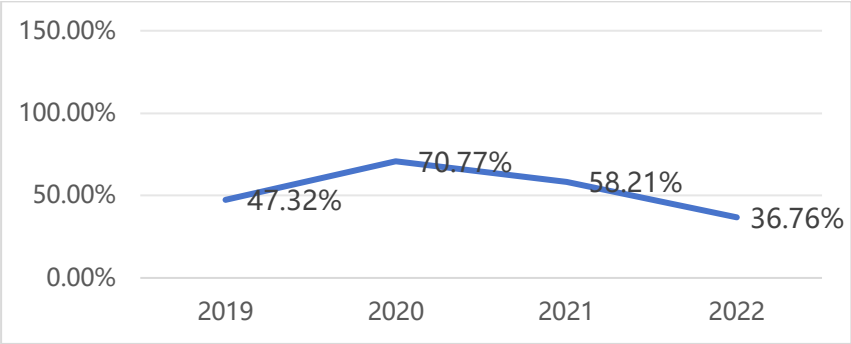


Fig. 6. Debt-to-asset ratio

The Debt-to-Asset ratio of Luckin Coffee from 2019 to 2022 is shown in the graph above. (Fig. 6) Luckin's debt-to-asset ratio was 47.32% in 2019, within the safe range (<60%). The financial fraud temporarily masked the real debt pressure, and the liability scale did not experience abnormal surges. In 2020, the debt-to-asset ratio soared to 70.77% due to regulatory penalties triggered by the fraud incident (a US\$180 million

fine by the US SEC and a RMB 61 million fine by Chinese regulators), investor litigation compensation (a US\$175 million settlement), causing the total liabilities to surge from RMB 4.62 billion to RMB 6.597 billion. Meanwhile, the company faced short-term liquidity problem, which further drove up its liabilities.

In 2021, the debt-to-asset ratio dropped to 58.21%, and further to 36.76% in 2022, significantly lower than the industry warning threshold. This improvement was attributed to restructuring measures such as closing inefficient stores and reducing subsidies, which reduced reliance on external financing. The company's return to profitability in 2021 also strengthened its own capital accumulation. The continuous decline in the debt-to-asset ratio indicates that Luckin has repaired its financial structure through deleveraging, reduced solvency risks, and reflected the effectiveness of its business model transformation from aggressive expansion to sustainable operations.

3.3 Traditional Risk Model Validation

The financial data used in the following risk model validation calculations are all derived from Luckin Coffee's financial reports from 2019 to 2022 [9-12].

Altman Z-score Model.

$$Z = 1.2X_1 + 1.3X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \quad (21)$$

The variables mentioned in this equation are calculated using the formula mentioned in 2.7 Altman Z-score Model. (Equation (21))

The financial data used in the Altman Z-score Model calculations are all derived from Luckin Coffee's financial reports from 2019 to 2022 [9-12]. The calculation results of Luckin Coffee from 2019 to 2022 are shown in the Table 1.

Table 1. Altman Z-score Calculation Results (2019-2022)

year	X ₁	X ₂	X ₃	X ₄	X ₅	Z-score
2019	0.33	-0.70	-0.33	4.93	0.31	1.67
2020	0.58	-1.34	-0.28	1.99	0.43	-0.35
2021	0.15	-0.96	-0.04	2.04	0.64	0.66
2022	0.31	-1.09	0.11	10.24	1.27	6.73

As shown in Table 1, during the fraud period (2019), Luckin Coffee's Z-score stood at 1.67, falling within the "grey zone." Although X₁ (working capital/total assets) was positive and X₄ (market value of equity/total liabilities) was extremely high, X₂ (retained earnings/total assets) and X₃ (EBIT/total assets) were negative, reflecting severe accumulated and operating losses. The manipulation of revenues and transactions caused the traditional model to fail in providing timely risk warnings.

In the early stages of restructuring (2020–2021), the Z-scores were -0.35 in 2020 and 0.66 in 2021, both in the risk zone, indicating financial pressures such as surging liabilities due to fraud exposure and losses during restructuring. In the recovery period (2022), the Z-score rose to 6.73, entering the "safe zone," with X₃ turning positive, X₄

surging, and X_5 significantly increasing, effectively reflecting improved financial health. The model demonstrated "lagged warning during fraud and effective feedback during recovery" in Luckin's case, exposing its limitations in detecting systematic data manipulation. Integrating non-financial indicators is necessary to enhance the ability to identify complex financial fraud.

Beneish M-Score.

$$\begin{aligned} \text{M Score} = & -4.84 + 0.92 \times \text{DSRI} + 0.528 \times \text{GMI} + 0.404 \times \text{AQI} \\ & + 0.892 \times \text{SGI} + 0.115 \times \text{DEPI} - 0.172 \times \text{SGAI} + 4.679 \times \text{TATA} - 0.327 \times \text{LVGI} \end{aligned} \quad (22)$$

The variables mentioned in this equation are calculated using the formula mentioned in 2.8 Beneish M-Score. (Equation (22))

The financial data used in the Beneish M-Score model calculations are all derived from Luckin Coffee's financial reports from 2019 to 2022 [9-12]. The calculation results of Luckin Coffee from 2019 to 2022 are shown in the Table 2.

Table 2. Beneish M-Score Calculation Results (2019-2022)

Year	DSRI	GMI	AQI	SGI	DEPI	SGAI	TATA	LVGI	M-Score
2019	1.375	0.792	1.378	3.598	0.542	0.574	-0.102	1.454	-0.379
2020	0.572	0.917	1.229	1.333	1.119	0.600	-0.346	1.495	-4.227
2021	1.125	0.844	0.729	1.975	1.406	0.564	0.046	0.822	-1.294
2022	0.912	0.980	1.425	1.669	1.182	0.757	0.045	0.632	-1.41

As Table 2 indicates, the Beneish M-Score significantly exceeded the warning threshold (-0.379 vs. -1.78) during Luckin Coffee's fraud period (2019), indicating the model effectively identified risks of financial manipulation. Specific manifestations included: abnormal fluctuations in the Days Sales Receivable Index (DSRI) and Gross Margin Index (GMI), reflecting inflated revenues and distorted costs; an excessively high Sales Growth Index (SGI) and a negative value in the Total Accruals to Total Assets ratio (TATA), revealing profit manipulation. Although the M-Score issued timely alerts, traditional financial models (such as the Altman Z-score), relying on historical data, showed lag in the face of systematic fraud.

During the restructuring phase from 2020 to 2022, the M-Score gradually declined to a safe zone (-1.29 in 2022), indicating the company's financial health had returned to normal. This improvement aligned with operational strategy adjustments: measures such as closing inefficient stores, reducing subsidy dependence, and optimizing cash flow effectively mitigated the distorting effects of fraudulent indicators.

In summary, the Beneish M-Score demonstrated potential in identifying financial fraud in the Luckin Coffee case, but its limitations should not be ignored. In the future,

integrating non-financial signals (such as user retention rates and store traffic anomalies) and revising model thresholds for high-growth, subsidy-driven business models will be essential to enhance sensitivity and proactivity in detecting complex fraudulent behaviors.

4 Conclusion

This study analyzes Luckin Coffee's financial data from 2019 to 2022, revealing the substantial impact of systematic financial fraud on corporate financial health and the lagged response of traditional risk quantification models (Altman Z-score and Beneish M-Score) in detecting sophisticated financial manipulation.

The research finds that manipulated financial metrics during the fraud period obscured genuine operational distress. Altman Z-score Model (Table 1) failed to provide timely warning signals in 2019, while the M-Score (Table 2) crossed the threshold (-1.78). Notably, restructuring outcomes in 2021–2022 demonstrate that when the company resumed authentic operations, the model indicators effectively reflected improvements in financial health.

This discovery highlights the limitations of relying solely on traditional financial metrics in high-growth, subsidy-driven business models. It underscores the necessity to integrate non-financial indicators such as abnormal store traffic and user retention rates, alongside revising model thresholds, to enhance timely detection of financial fraud.

Providing empirical evidence for refining corporate financial risk assessment frameworks, this study advocates for stakeholders to strengthen monitoring of non-financial signals while utilizing quantitative models, thereby constructing a more comprehensive fraud early-warning mechanism.

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