Validity of Fraud Detection Models on Fraudulent US-listed Chinese Companies

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Abstract. This paper examines the effectiveness of Beneish M-Score and Dechow F-Score models in detecting financial frauds of US-listed Chinese companies. In conclusion, based on the data we collected, the validity for M-Score on US-listed Chinese companies is 85.71%, way higher than what Aghghaleh measured for American companies of 73.17%. The calculation and analysis of these models reveals that (1) Beneish M-Score indicates high validity among Chinese companies, while (2) Dechow F-Score fails to identify financial fraud correctly in our selected pool of Chinese companies. This paper evaluates the potential ways of preventing frauds in the light of the samples we collected.

Keywords: Chinese Companies, Fraud Detection Models, Beneish M-Score, Dechow F-Score

1 Introduction

The number of Chinese companies that are listed in the US has increased significantly. According to the US-China Economic and Security Review Commission, there were over 260 Chinese firms that were listed on the American stock exchanges in March 2022. These companies have a combined market capitalization of over \$1 trillion as of March 2022, (USCC.GOV). Despite the presence of these companies, they are still censored by the US Securities and Exchange Commission.

The increasing number of Chinese companies being investigated for frauds related to their financial transactions has highlighted the importance of identifying these types of frauds. This paper aims to analyze the various models used by financial firms to identify frauds and compare them with those used by US companies.

This paper also aims to analyze the various factors that affect the results of investigations regarding the financial transactions of Chinese companies.

2   Research Design

The paper aims at identifying the individuals who have already committed fraud in the US and then uses three different models to analyze the validity of the various models used to identify frauds in Chinese companies. These models are the Dechow F-score, Beneish M-score, and Industrial comparison.

The Beneish M-Score is the "a suggested model for detecting manipulation" (Beneish, 1999) in the United States that illustrates a credible index to identify whether American companies committed fraud or not. Based on different criteria that are calculated through the financial statements, the score reveals the likeliness of fraud. Based on eight variables--Days' Sales in Receivables Index (DSRI), Gross Margin Index (GMI), Asset Quality Index (AQI), Sales Growth Index (SGI), Depreciation Index (DEPI), Sales, General and Administrative expenses Index (SAI), Leverage Index (LVGI), Total Accruals to Total Assets (TATA), the M-Score is calculated through the equation and, normally, an M>-2.22 indicates a potential manipulator. (An, 18):

M-Score = $-4.84 + 0.92 \times$ DSRI $+ 0.528 \times$ GMI $+ 0.404 \times$ AQI $+ 0.892 \times$ SGI $+ 0.115 \times$ DEPI $-0.172 \times$ SGAI $+ 4.679 \times$ TATA $- 0.327 \times$ LVGI

The Dechow F-Score is developed by Dechow el, al. (2011) The calculation consists of serveral steps, which will finally generate the value that represents the final F-Score.

Predicted   value   =   -7.893   + 0.790*rsst_acc+2.518*ch_rec+1.191*ch_inv+1.979*soft_assets + 0.171*ch_cs – 0.932*ch_roa + 1.029*issue Probability of manipulation = e^Predicted value/ (1 + e^Predicted value) where e=2.71828183 F score= Probability of manipulation/0.0037

If the F-Score obtained shows less than 1 (<1), it will show that there is no manipulation of the financial statements. If the F-Score exceeds 1 (> 1), it can be a signal of an indication of fraud in the company's financial statements. (Ratmono, et, al.)

Aghghaleh et al. found that the Beneish M-Score and the Dechow F-Score individually indicated an accuracy of 73.17% and 76.22%. (2016) This means the models predict US fraudulent firms successfully. Yet, the validity of such on US-listed Chinese companies needs to be verified.

The paper matches the data of the fraudulent Chinese companies with those of the same type that are listed in the US. In most cases, a company from the same industry can be considered a US company that's similar to the one from China. This is because there is no Chi-nese company that's similar to the one from China that's on the same stock exchange.

To maintain their legitimacy, Chinese companies should carefully consider the various criteria that are used to identify frauds in their operations. For instance, if a company is involved in the beverage industry, then it should be considered a comparable company.

One of the most important factors that Chinese companies should consider when it comes to identifying frauds is the size of their company. For instance, if a company has

a large number of employees and is operating in a normal year, then it should be considered a comparable company. Years that have passed since the fraud committed by the company have to be close to the year that the fraud took place.

The paper then uses the various models that are used to identify frauds in Chinese companies to find out if they're useful in identifying these types of frauds. To get more credible results, the paper will use an industrial comparison to analyze the data of the fraudulent Chinese companies. Each of the models will be evaluated to see if they're compatible with the data.

3   Data/ Sample Selection

We have chosen 7 US-listed Chinese companies that have admitted or been exposed to financial frauds within the past 15 years as the object of this paper. The standard selection of these companies is considerably strict. These companies' fraudulent activities should be confirmed by SEC or self-exposure. Unverified claims of fraud from third parties' short reports, such as some from Muddy Waters or Citron Research, does not fit into our consideration due to the lack of authority confirmation.

We calculate both the M-Score and F-Score of these 7 companies in compared with the benchmarks of the two models to evaluate whether they verify or reject the fraud models. To obtain a horizontal comparison, we also calculated the financial fraud indicators of the comparable. US-listed Chinese/US local companies in the same industry with those of these Chinese companies. These companies span multiple sub-industries, so we will also extract industry average data to give these Chinese companies a more intuitive horizontal indicator comparison. Despite many fraudulent US-listed Chinese companies being charged such as RINO and AgFeed (hence, they are not suitable as samples), which forged the financial statement thoroughly when it first showed on the list in the US market, this paper still obtained data for companies that can see a difference before and after the fraud.

US-listed Chinese Company	Comparable US company	Industry	Fraud Period	Fraud Type
Universal Travel Group (UTA)	Expedia Group Inc. (EXPE)	Travel	2010	Revenue/ Expense / Internal Transaction
Focus Media Holding Limited (FMCN)	Lamar Advertising Co (LAMR)	Advertising	2011	Asset/ Expense/Internal Transaction
ShengdaTech Inc. (SDTH)	Celanese Corp (CE)	Chemical	2008	Revenue/ Expense/ Operation
Luckin Coffee. (LKNCY)	Starbucks (SBUX)	Beverage & Food	2019-2020	Revenue/ Expenses/ Net operating loss
Longtop Financial Technology (LFT)	Fiserv Inc (FISV)	Financial	2009-2010	Revenue
China Northeast Petroleum Holdings Limited (NEP)	ConocoPhillips (COP)	Petroleum	2009-2010	Embezzlement/Internal Transaction

TAL Education Group (TAL)	New oriental Education & Tech Group (EDU)	Education	2019	Revenue

Fig. 1. This sheet lists all 7 companies and their comparable counterparts as well as the industries fraud years and types.

3.1   Luckin Coffee

Luckin Coffee is based in Xiamen, China which is the largest coffee chain brand in China. In October 2017, the first store of Luckin Coffee opened in Beijing, and after four months of product, process and operation system integration, Luckin Coffee has completed the layout of 525 stores across China and announced its official opening. On May 17, 2019, Luckin Coffee landed on Nasdaq Stock.

3.2   TAL Education

TAL Education was founded in China in 2003 which is a technology education company with smart education and open platform, quality education and extracurricular coaching as the carrier, serving public education, helping private education and exploring new models of future education in a global scale. On October 20, 2010, TAL Education was listed on the New York Stock Exchange, becoming the first Chinese primary and secondary education institution to be listed in the US.

3.3   Universal Travel Group

Universal Travel Group is a leading online travel service provider in China that provides domestic and international air ticket sales and other travel-related services. It also offers hotel reservations and tours. Through its customer service offices and online platforms, it has become one of the country's fastest growing companies in the travel industry.

3.4   Focus Media Holding Limited

China's largest digital media company, Focus Media Holding Limited, is focused on providing a comprehensive digital media platform to the urban mainstream consumer. In July 2005, it was the first Chinese pure advertising media company to be listed on the Nasdaq Stock Exchange. Through its initial public offering, the company raised $172 million, which is the largest amount of money raised by a Chinese media company in an IPO. Its market value has exceeded $7 billion.

3.5   ShengdaTech Inc.

ShengdaTech, Inc. is a China-based company that develops, produces, and markets nano precipitated calcium carbonate. The company's products are mainly sold through

its direct sales force in China. In 2006, it was the first nanotechnology company from China to be listed on the US stock exchange.

3.6   Longtop Financial Technologies Limited

LFT, or Longtop Financial Technologies Ltd., mainly serves the financial services industry, such as banks, insurance companies, and funds. It also provides various software products and services to other companies. Its business scope includes planning consulting, software development, and implementation services.

3.7   China Northeast Petroleum Holdings Limited

China Northeast Petroleum Holdings Inc. is a holding company that focuses on the oil and natural gas industry. It was listed on the Mini-Market of the Nasdaq in July 2003. Through its subsidiary, the company is able to receive a reverse take-over of a publicly traded company in the US. This type of deal is allowed under the Securities Act of 1933, as well as federal regulations and laws.

4   Analysis and Results

4.1   Luckin Coffee

According to the report offered by SEC, Luckin Coffee had committed a fraud in 2019-2020 by materially misstating the company's revenue, expenses, and net operating loss in an effort to falsely appear to achieve rapid growth and increased profitability and to meet the company's earnings estimates. (SEC) Despite the fact that there is no previous data before the fraud, Luckin Coffee did have honest data after the fraud in 2021. Therefore, it is useful to compare the set during and after the fraud. The comparable company for Luckin coffee is the DAVIDsTEA (DTEA). According to the website, Tea-obsessed since 2008, DAVIDsTEA are on the ground worldwide in search of well-crafted, single-origin loose leaf teas to share with North American community. It has offline shops that sell beverage of tea drinks as well as the leafs.
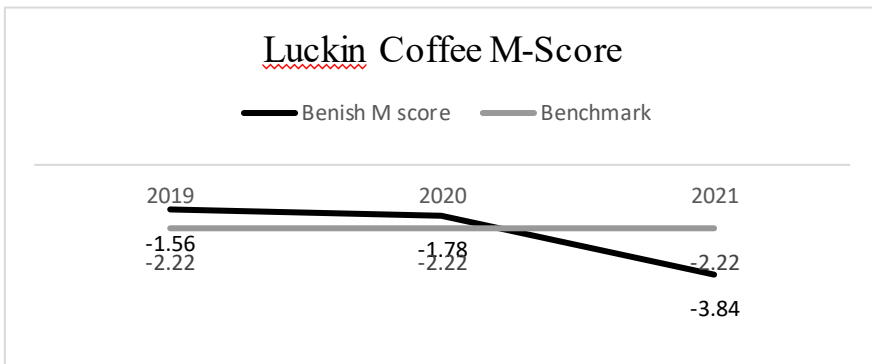
Beneish M-Score Calculation	2019	2020	2021
Day Sales in Receivables Index (DSRI)	2.351	0.829	2.469
Gross Margin Index (GMI)	1.263	1.091	1.184
Asset Quality Index (AQI)	0.640	3.208	1.934
Sales Growth Index (SGI)	3.598	1.333	1.975
Depreciation Index (DEPI)	1.662	1.080	1.083
SG&A Expenses Index (SGAI)	0.574	0.600	0.438

| Leverage Index (LVGI) | 1.636 | 0.227 | 4.986 |
| Total Accruals to Total Assets (TATA) | -0.089 | -0.102 | -0.346 |

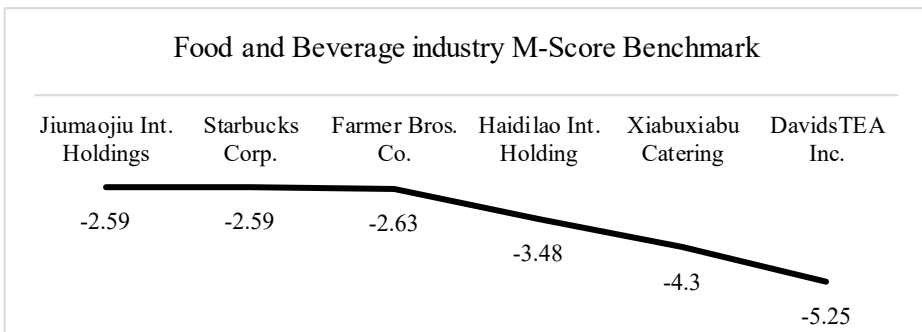**Fig. 2.** Beneish M-score Calculation (2019- 2021)

The chart below shows the comparison between the M-score and the financial statement of Luckin Coffee. Since its fraudulent years were detected in 2020, the year 2019 has a high M-score. This means that the company's financial statement was prepared according to fraudulent methods.

Due to the fact that Luckin Coffee fabricated its financial statements, including its expenses and net sales, its M-score significantly exceeded that of DAVIDsTEA. In 2019, Luckin Coffee had a 1.82 times SGI compared to DAVIDsTEA's 1.18 times.

Luckin Coffee M-Score

— Benish M score   — Benchmark

| 2019 | 2020 | 2021 |

-1.56
-2.22

-1.78
-2.22

-2.22

-3.84

Fig. 3.

Figure 3: After calculating the M-Score, we found that Luckin Coffee saw an increase in fraud years and a tremendous decrease in M-Score in 2021. Since the value above -2.22 means a potential risk of fraud. Luckin Coffee fits the M-Score evaluation. The Standard deviation is 1.63. The individual variables are listed below. *Data from: Luckin Coffee Inc. "Form 20-F." *Sec.gov*, 31 Dec. 2021,

Food and Beverage industry M-Score Benchmark

| Jiumaojiu Int. Holdings | Starbucks Corp. | Farmer Bros. Co. | Haidilao Int. Holding | Xiabuxiabu Catering | DavidsTEA Inc. |

-2.59

-2.59

-2.63

-3.48

-4.3

-5.25

Fig. 4.

Figure 4: The companies that are in the food and beverage industry with a 5-year history have an average M-Score of -3.47, while the medium is -3.06 and the standard deviation is 1.11. Despite this, the number of Luckin that has an M-Score of -3.475 during a fraud year is significantly higher than the industry average. This is because, in the subsequent years, the number dropped to -3.84, which is considered to be honest.
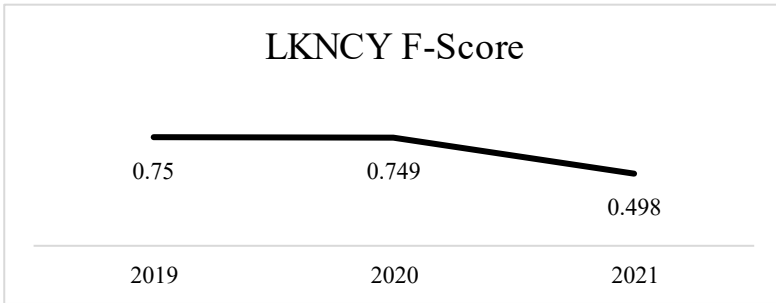

Fig. 5.

Figure 5: The results of the Dechow F-score are abnormal. For instance, all of the values for Luckin Coffee are below the benchmark. This means that it was not a manipulator. However, a similar tendency can be observed when comparing the F-score with the M-score.

The graphs indicate that the number of fraudulent Chinese companies operating in the US has increased in 2019 and 2020. However, this figure has significantly decreased in 2021. It is believed that the general benchmark for these companies should be lower than 1.

Table 1. M-Score & F-Score

SCORE	Luckin Coffee (LKNCY)	DAVIDsTEA (DTEA)	Industry	Fraud Possibility
M-SCORE Average	-1.18	-4.46	-3.47	Very Likely
F-SCORE Average	0.67	0.34	/	Not applicable

Table 1: Therefore, M-Score is suitable for Luckin Coffee. With the help of the Beverage & Food industry as well as the comparable company DAVIDsTEA, it can be found out that F-Score seems to confront a abnormality that did not identify the true manipulation of Luckin Coffee.

4.2   Universal Travel Group

In 2013, the Securities and Exchange Commission accused former Chairman and Chief Financial Officer of the company, Jing Xie, and former Chairman and Chief Executive Officer of the company, Jiangping Jiang, of failing to report to the public about about

about $40 million in cash transfers that they made to various entities in China and the Hong Kong.

The Commission accused the defendants of making false and misleading statements in their 2010 annual reports. It also claimed that the company had misstated its revenues and profits in 2010.

Expedia is a leading online travel agency that helps travelers plan their trip and book their accommodations. With a wide selection of accommodations and vacation pack-ages, custom-ers can find the perfect travel experience.
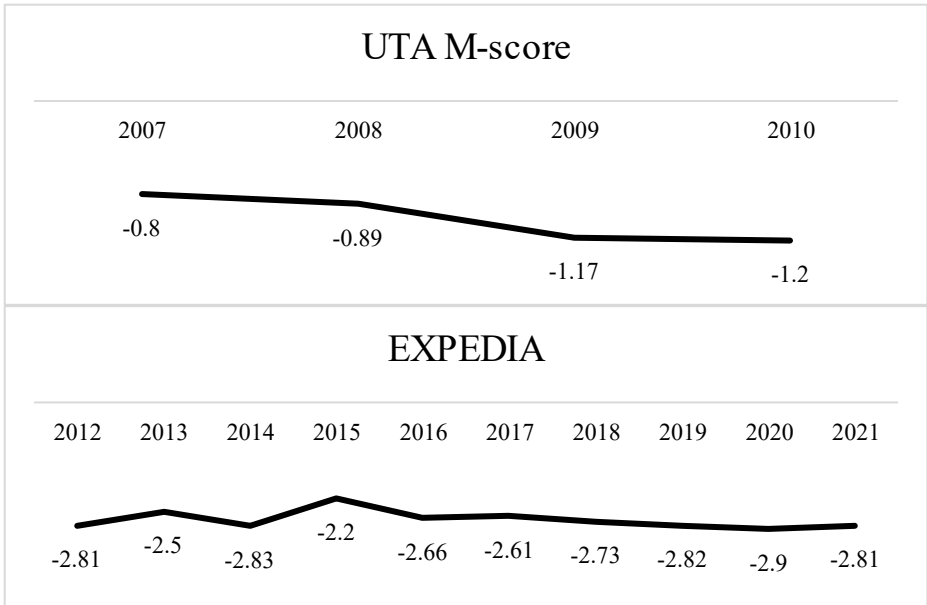

Fig. 6.

Figure 6: When we compare the M-Scores between the two, it is not difficult to find that the M-Score of UTA is higher than the -2.2 benchmark with an average of -1.02 while the average for Expedia in the last ten years is -2.69.
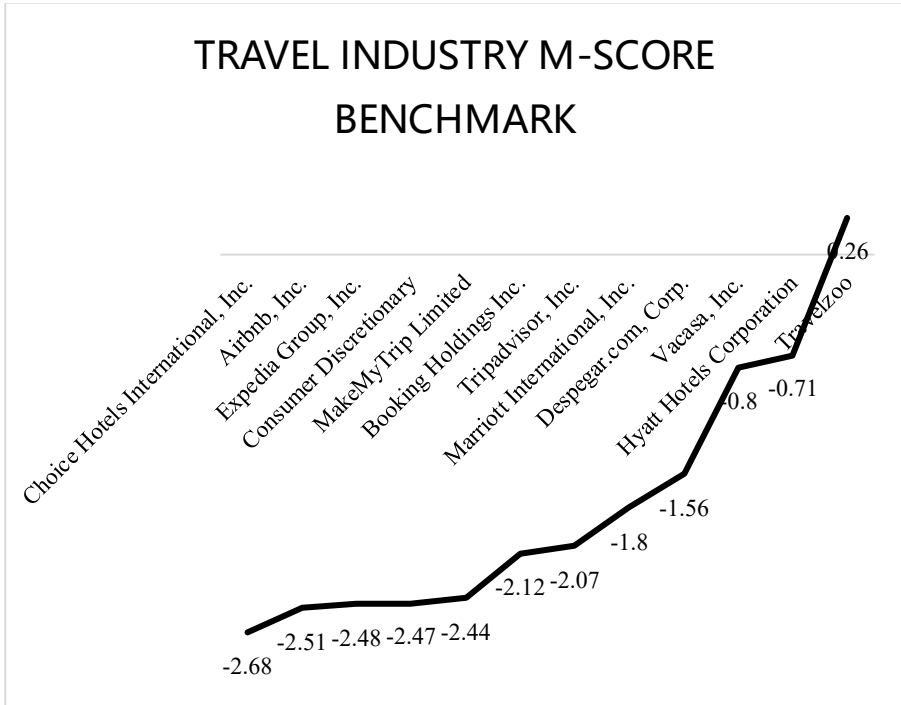
Fig. 7.

Figure 7: For 12 companies in the travel industry, the average of their M-Score bench-mark is -2.095 with a median of -2.12. Comparing both to the cutoff point at -2.00 (Beneish et al., 2012) and the industry average, UTG's M-score is indicating a high possibility of commiting fraud. *Original Data from: Universal Travel Group, "Form 20-F", sec.gov.

Table 2. Beneish M-Score Calculation

Beneish M-Score Calculation	2009	2010
Day Sales in Receivables Index (DSRI)	1.42	1.33
Gross Margin Index (GMI)	1.08	1.14
Asset Quality Index (AQI)	0.43	1.65
Sales Growth Index (SGI)	1.25	1.6
Depreciation Index (DEPI)	5.82	0.09
SG&A Expenses Index (SGAI)	-0.65	1.47
Leverage Index (LVGI)	0.72	1.02
Total Accruals to Total Assets (TATA)	-0.01	0.06

In order to identify the financial problems of UTA, we have conducted a comprehensive analysis of its M-score. We have identified three abnormal indexes that are related to its business. One of these is the high number of receivables, which accounts for over 20% of the company's total assets. In addition, the company's SGAI shows that it has little expense and high revenue.

Table 3: Although the F-score cutoff point is 1.00, it is still possible for firms to commit fraud since over 50% of them have an F-score of 1.4 or higher. Based on Dechow's analysis, this means that 2.49 is still high enough to make a firm susceptible to fraud.

Table 3.

	Universal Travel Group (UTA)	Expedia Group Inc. (EXPE)	Industry	Fraud Possibility
M-SCORE Average	-1.02	-2.69	-2.095	Very Likely
F-SCORE	2.49	1.28	/	Highly Likely

Although the F-score is based on a cutoff point of 1.00, it is still possible for companies to commit fraud due to the high number of false and misleading statements. In a paper published in 2011, Dechow noted that over 50% of the misstated firms had F-scores of 1.4 or higher.

4.3   Focus Media Holding Limited

Lamar Advertising is a large outdoor media company that has offices in the US and Canada. It has a total of 356,000 square feet of space in these regions. It is one of the most prominent firms in these areas.

FOCUS MEDIA M-Score

| 2008 | 2009 | 2010 | 2011 | 2012 |
| -4.59 | -6.19 | -2.51 | -2.79 | -2.63 |
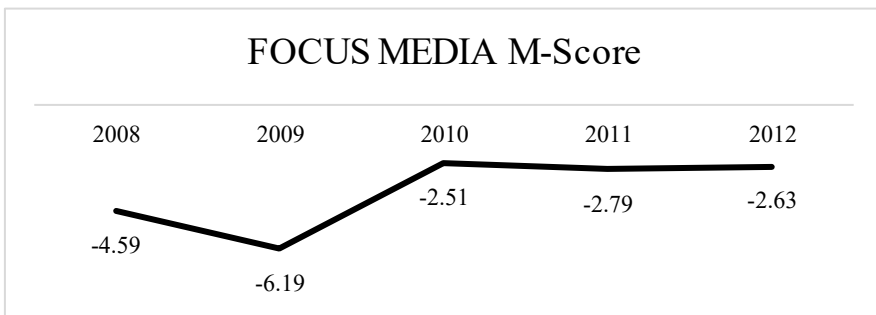
Fig. 8.

Figure 8: Besides these types of displays, Lamar also provides advertisers with various other advertising formats, such as airport and interstate logos. These allow them to reach a wide audience and reach local audiences.

LAMAR ADVERTISING COMPANY M-Score

| 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |

-2.7   -2.72   -2.67   -2.63   -2.62   -2.66   -2.67

-2.9   -2.95   -2.77

Fig. 9.

Figure 9: In 2010, the M-Score of Focus Media was stable, as it was re-audited following the company's financial statements. Before that, the previous years had been unstable and had very small M-scores. This suggests that the company might be committing fraud. During the five years that the company has been in existence, the average M-score has been around -3.742, while the average for Lamar Advertising is around -2.729.

RELATED INDUSTRY M-SCORE BENCHMARK

LAMAR ADVERTISING COMPANY · Medalist Diversified REIT, Inc. · Omnicom Group Inc. · The Interpublic Group of Companies,… · Uniti Group Inc. · Clear Channel Outdoor Holdings, Inc. · RLJ Lodging Trust · Park Hotels & Resorts Inc. · Outfront Media Inc.

-2.08

-2.17

-2.26

-2.39

-2.6   -2.55   -2.54   -2.5   -2.49
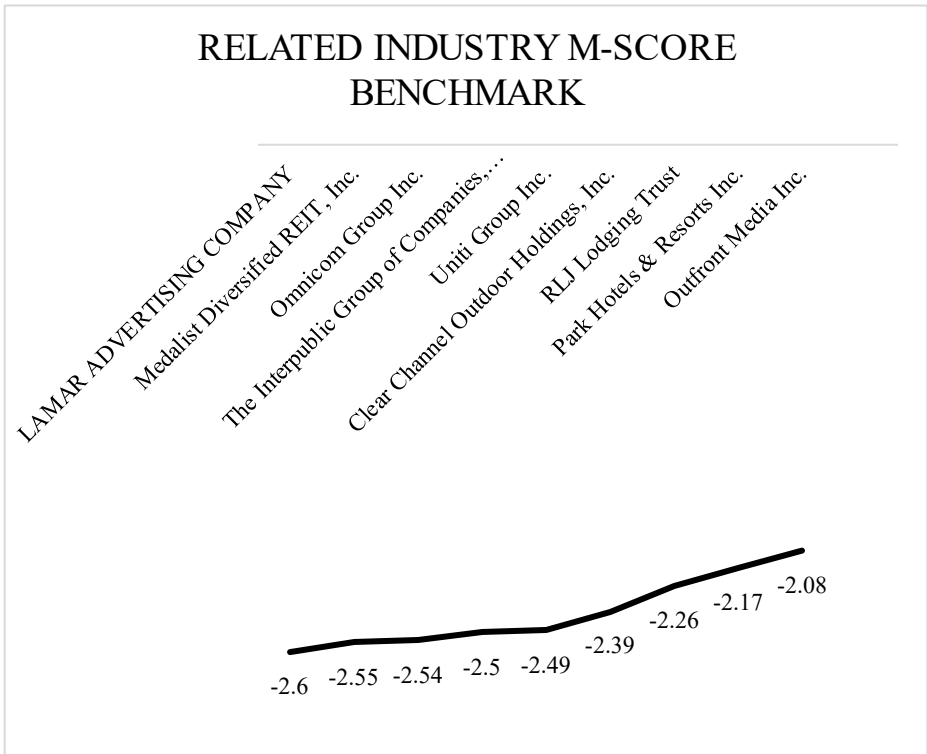
Fig. 10.

Figure 10: The industry as a whole has a lower M-score than Lamar Advertising. Both companies have average M-scores of -2.398. Although the figures for 2008 and 2009 are below the cutoff point, they are still too far away from the red flags that are usually detected when a company is operating under fraud.*Original Data from: Focus Media, "Form 20-F", sec.gov.

Table 4: The DSRI and SGI of Focus Media are abnormal indicators that show the company's financial condition. In 2007, the company had negative accounts receivables, and in 2008, it incurred a negative net income due to its overstatements in asset and expense. Despite the revenue that the company generated in 2008, it still incurred a negative net income because of its overstatements.

Table 4.

Beneish M-Score Calculation	2009	2008
Day Sales in Receivables Index (DSRI)	-1.85	0.42
Gross Margin Index (GMI)	1.30	0.49
Asset Quality Index (AQI)	1.14	0.86
Sales Growth Index (SGI)	0.75	3.25
Depreciation Index (DEPI)	2.06	0.34
SG&A Expenses Index (SGAI)	1.39	1.62
Leverage Index (LVGI)	0.67	1.63
Total Accruals to Total Assets (TATA)	-0.27	-0.61

F-score is suggesting both companies have a high possibility of conducting fraud, so F-score is not applicable here.

4.4   ShengdaTech Inc.

Celanese Corporation is a major chemical company that makes various specialty materials and differentiated chemicals. It is based in Irving, Texas, and is known for its acetic acid and vinyl acetate manufacturing businesses. It is also the world's largest producer and supplier of acetic acid.
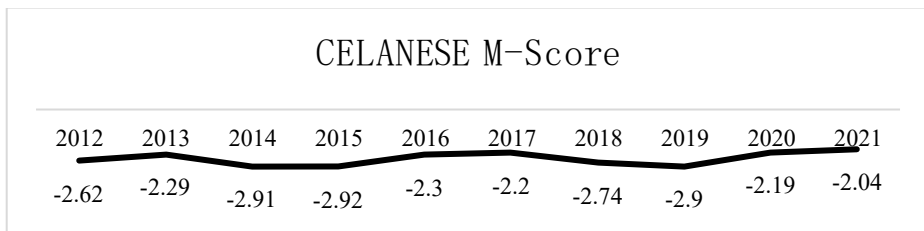

SHENGDA TECH M-Score

2007 -1.87

2008 -2.1

2009 -2.87

CELANESE M-Score

2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
-2.62	-2.29	-2.91	-2.92	-2.3	-2.2	-2.74	-2.9	-2.19	-2.04
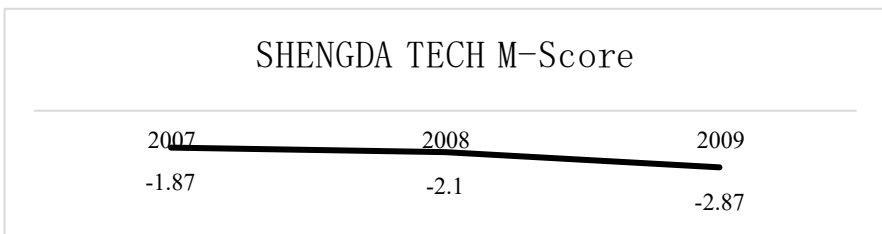
Fig. 11.

Figure 11: Considering that there are not many available annual reports of Shengda Tech, there are limited M-Scores to calculate, but the average M-score is -2.28 while Celanese has an average of -2.511.
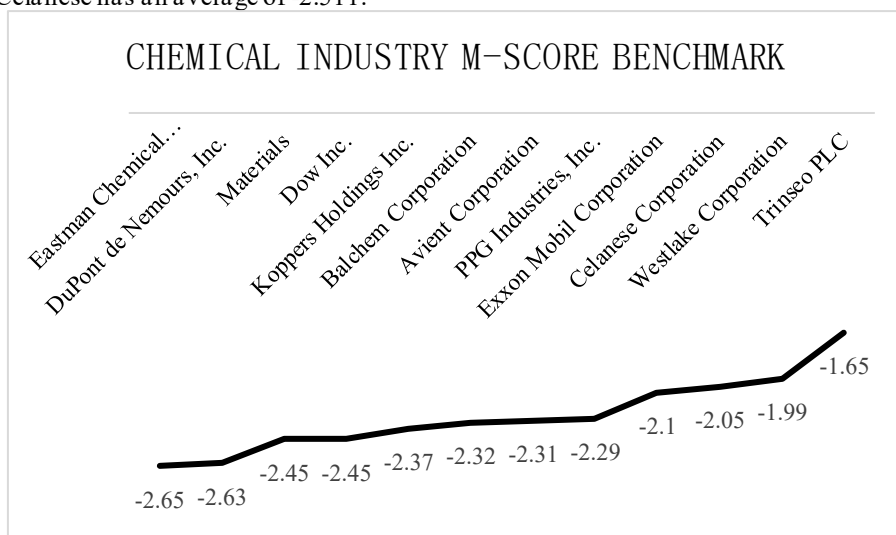
CHEMICAL INDUSTRY M-SCORE BENCHMARK

Eastman Chemical... / DuPont de Nemours, Inc. / Materials / Dow Inc. / Koppers Holdings Inc. / Balchem Corporation / Avient Corporation / PPG Industries, Inc. / Exxon Mobil Corporation / Celanese Corporation / Westlake Corporation / Trinseo PLC

-2.65 -2.63 -2.45 -2.45 -2.37 -2.32 -2.31 -2.29 -2.1 -2.05 -1.99 -1.65

Fig. 12.

Figure 12: The industry average is -2.272 and it is very close to Shengda's average M-score. So M-score doesn't apply to this case perfectly and we will calculate its F-score.

Table 5: The difference is very minor, but it still applies to the 1.00 cutoff point nicely. Hence, we conclude that F-score works in this case, suggesting that the company is likely commiting fraud.

Table 5.

	Shengda Tech Inc. (SDTH)	Celanese Corp (CE)	Indus-try	Fraud Possi-bility
M-SCORE Average	-2.28	-2.511	-2.272	Possible
F-SCORE	1.03	0.82		Likely

4.5   Longtop Financial Technologies Limited

For four straight quarters in 2010, LFT was shorted by Citron Research. The company was also questioned about its management's background and unfair audit process. On May 23, 2011, the US Securities and Exchange Commission launched an investigation into the company. On August 23, 2011, Longtop Financial was delisted from the New York Stock Exchange. The company had admitted to misleading the market about its financial condition.

From 2009 to 2010, the M-Scores of Longtop Financial Technologies were calculated. The company was a part of the New York Stock Exchange's exchange. Usually, an M-score of 2 or more indicates that a potential investor is likely to be manipulated. Two years after it was listed on the US stock market, the M-Scores of LFT have shown that it is highly likely to be manipulated.

Table 6: LFT's M-Scores calculated from 2009 to 2010 are listed below *Data from: LONGTOP FINANCIAL TECHNOLOGIES LIMITED Inc. "Form 20-F,"*Sec.gov*,16 Jul.2010, 29 Jun. 2009, 1 Jul.2008 https://www.sec.gov/edgar/search/#/dateRange=all&category=form-cat1&ciks=0001412494&entityName=LONGTOP%2520FINANCIAL%2520TECHNOLOGIES%2520LTD%2520 (CIK%25200001412494)

Table 6.

Beneish M-Score Calculation	2009	2010
Day Sales in Receivables Index (DSRI)	0.871	1.381
Gross Margin Index (GMI)	0.929	1.051
Asset Quality Index (AQI)	1.486	1.943
Sales Growth Index (SGI)	1.613	1.59
Depreciation Index (DEPI)	1.135	1.47
SG&A Expenses Index (SGAI)	0.42	1.081
Leverage Index (LVGI)	1.025	1.407
Total Accruals to Total Assets (TATA)	0.005	-0.006

The DSRI index has suddenly shown a significant increase, which suggests that the business environment is going to deteriorate. It has been forced to make various sales credit adjustments to boost its sales, which will likely result in early recognition of revenue. The other measure of the company's performance, the DEPI, also showed an upward trend, from 1.135 to 1.47. This indicates that the depreciation rate of the organization has been declining.

Longtop was found to have underreported its earnings by altering the value of its assets and other financial measures. This could cause its earnings to increase. In addition, the LEVI index, which measures the financial risk of the company, has increased

from 1.025 to 1.407. This suggests that the company's financial situation is becoming more unstable.

One of the Fortune 500 companies that provides information technology services to financial institutions is Fiserv. It has been ranked as the leading provider of financial services technology in the US in a 2004 survey. Due to the lack of financial statements from Longtop's 2010 listing, only two M-score figures were available.

The M-score of Longtop is similar to that of its competitors. However, it has increased significantly over the past two years, which suggests that financial fraud is on the rise.

Table 7: The LFT's M-Score is compared with that of five creditworthy companies. It shows that the basic value of the score does not change much except that the one in Chicago is lower than the others. The average of the M-score of these companies is -3.372, while the median is -3.08. The difference between the M-score of LFT and the other companies' averages can be used to measure the reference value of the score for financial fraud.

Table 7.

M-Score	2009	2010
LFT	-1.76	-1.32
FISV	-2.72	-2.73
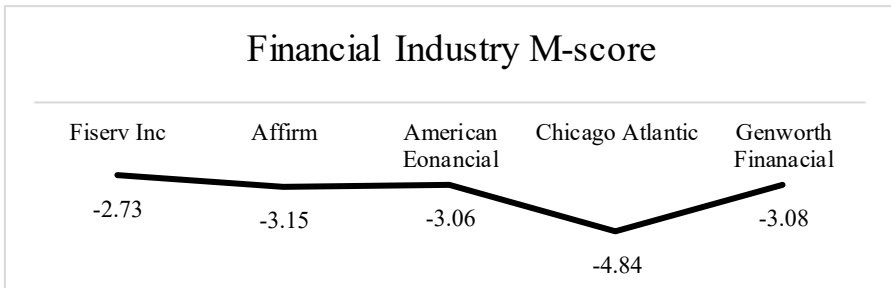
Fig. 13.

Figure 13. After analyzing the data for the years 2010 and 2019, it shows that the LFT's F-score is less than 1, which means that it is not prone to financial fraud. However, its F-score in 2010 and 2009 was not in the same range as that of other companies. This means that the LFT's F-score is not appropriate for this situation.

Table 8. LFT's F-Score in 2010 and 2009

| F-Score	2009	2010
LFT	0.861	0.981
FISV	0.707	0.739

4.6   TAL Education

On April 7, 2020, TAL Education released the results of its internal inspection. The company revealed that one of its executives had violated its code of conduct by intentionally misleading the public about the sales revenue of its new business line, which is known as the Light Class to B business. In addition, the company was also questioned about the financial reports it submitted in 2018.

Table 9: *Data from: TAL EDUCATION GROUP Inc," Form 20-F," *Sec.gov*,30 Jun,2020. 16 May.2019, 26 Jun.2018, 28 Jun,2017. https://www.sec.gov/edgar/search/#/dateRange=all&category=form-cat1&ciks=0001499620&entityName=TAL%2520Education%2520Group%2520(TAL)%2520(CIK%2520000149 9620)

Table 9.

Beneish M-Score Calculation	2018	2019	2020
Day Sales in Receivables Index (DSRI)	1.071	1.387	0.865
Gross Margin Index (GMI)	1.124	1.010	0.987
Asset Quality Index (AQI)	1.215	1.067	0.585
Sales Growth Index (SGI)	1.494	1.277	1.373
Depreciation Index (DEPI)	1.232	1.015	0.990
SG&A Expenses Index (SGAI)	1.133	1.213	1.236
Leverage Index (LVGI)	0.713	1.172	0.750
Total Accruals to Total Assets (TATA)	-0.161	0.046	-0.177
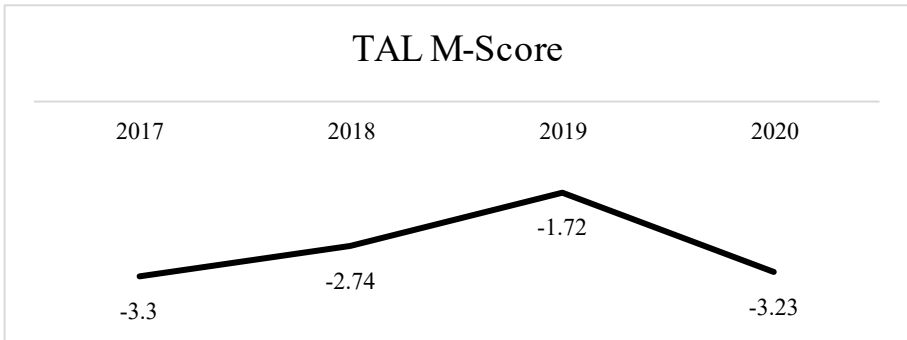
Fig. 14.

Figure 14: Comparing the M-score of the LFT with that of the other companies for the years 2010 and 2019, it shows that the value of the score increased by more than -2.22. This means that the company is more prone to financial fraud. However, the M-score can still accurately identify the year of the fraud.

Table 10: Analyzing the data for the educational industry, it shows that the average M-score of the companies is not affected by financial fraud. The results of the study show that New Oriental Education & Technology, which is a China-based company that has the same operating model as TAL Education, is unlikely to be manipulated. In this case, the M-score can be used to identify financial fraud.

Table 10.

M-SCORE	TAL Education (TAL)	New Oriental Education (EDU)	Industry
M-SCORE Average	-1.72	-2.36	-2.59
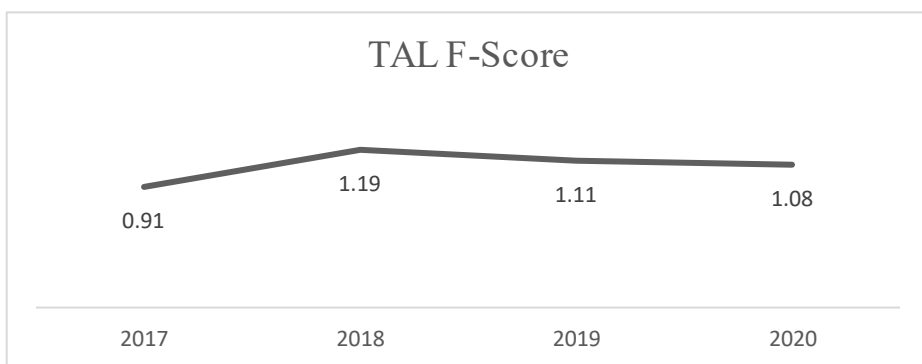
Fig. 15.

Figure 15: Analyzing the financial records of the company in 2019, it was clear that its F-score exceeded 1.00. This means that it is more susceptible to financial fraud. However, after analyzing its operations over the next couple of years, it shows that its values have remained relatively high. This means that the F-system does not work and there's no reason to suspect that the company is actually committing fraud.

China Northeast Petroleum Holdings Limited

On March 1, 2012, the Securities and Exchange Commission (SEC) requested that the New England Properties (NEP) suspend trading for two weeks due to the company's incomplete and inaccurate financial information. The agency also noted that the company's cash transactions from 2009 were suspicious. In response, the company issued a statement that revealed that it was taking the investigation seriously.

Table 11: *CHINA NORTH EAST PETROLEUM HOLDINGS Inc, "Form 10-K."Sec.gov,3 Sept.2010,30 Mar.2009, 31 Mar.2008 https://www.sec.gov/ed-gar/search/#/dateRange=all&category=form-cat1&ciks=0000787251&enti-tyName=CHINA%2520NORTH%2520EAST%2520PETROLEUM%2520HOLDIN GS%2520LTD%2520(CIK%25200000787251)

Table 11.

Beneish M-Score Calculation	2009	2010
Day Sales in Receivables Index (DSRI)	0.29	3.476
Gross Margin Index (GMI)	0.846	0.917
Asset Quality Index (AQI)	0.203	1.436
Sales Growth Index (SGI)	3.006	1.104
Depreciation Index (DEPI)	1.029	0.938
SG&A Expenses Index (SGAI)	0.741	0.949
Leverage Index (LVGI)	-0.18	-0.306
Total Accruals to Total Assets (TATA)	0.694	1.086
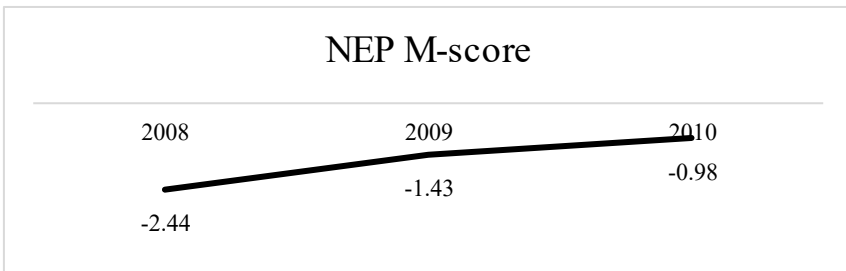
Fig. 16.

Figure 16: The M-score of New Oriental Education & Technology has been significantly increased since it was delisted from the stock exchange in 2010. From 2008 to 2010, its growth trend was multiplied by the various factors that affected its performance. In 2008, the company's M-score was at -2.44, but it broke through and hit a value of -1.43. The value of the DSRI, which measures the company's financial strength, increased in 2009 as a result of financial manipulation. Usually, businesses have stable receivables and are not affected by financial fraud. However, an increase in the DSRI can cause them to increase their sales by adjusting their sales credits.
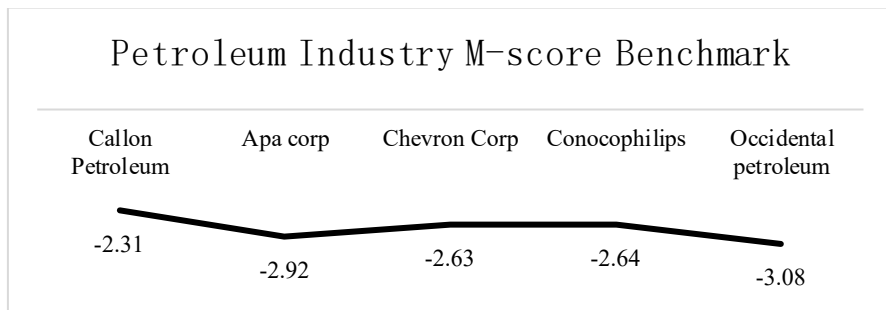
Petroleum Industry M-score Benchmark

Callon Petroleum	Apa corp	Chevron Corp	Conocophilips	Occidental petroleum
-2.31	-2.92	-2.63	-2.64	-3.08

Fig. 17.

Figure 17: The table shows the M-score of the five major oil companies in the same industry. It shows that the range of M-score changes is not too large, with an average deviation of 0.2967 and a standard deviation of -2.716. It indicates that the continuous M-score improvement is very stable. The difference between the industry and NEP is that the former has a much higher M-score after 2008.

One of the biggest energy companies in the US is Conocophillips. By comparing the average F-scores of the two companies in the past year, we can see that the former has a COP of below 1, which indicates that financial fraud is not possible. On the other hand, the latter has a high risk of being involved in fraud. This difference in the F-scores shows that there is a significant amount of financial fraud involved in this case.

Table 12: Comparing the performance of the National Energy Program (NEP) with that of five other companies. One of the companies we will discuss is Conocophillips. The company is an integrated energy company that engages in the exploration, production, and marketing of oil and gas.

Table 12.

SCORE	China North East Petroleum Holdings Limited (NEP)	ConocoPhillips (COP)	Fraud Possibility
M-SCORE Average	-1.61	-2.70	Very Likely
F-SCORE Average	3.25	0.75	Very Likely

5   Findings

We define the $X_{\Delta M\text{-Score}}$ as the indicator of both general value above the M-Score benchmark -2.22 and the general value above the industry average. Xc bar is the average M-Score value of the company and Xi bar is the average M-Score for the industry. The following equation is used to determine the weather M-Score for US-listed Chinese company works well or not. Every year's $X_{\Delta M\text{-Score}}$ is calculated, average, and round up to generate the overall $X_{\Delta M\text{-Score}}$ in the sheet below

$$X\Delta mscore = 0.5(\frac{\overline{Xc}+2.22}{|\overline{Xc}+2.22|} + \frac{\overline{Xc}-Xi}{|\overline{Xc}-Xi|}) \tag{1}$$

If the $X_{\Delta M\text{-Score}}$ equals to 1, then M-Score works well for this particular company. If the $X_{\Delta M}$-Score is not 1 then, M-Score is not suitable for such a company.

We define the indicator of F-Score below. Xf is the F-Score of the fraudulent company. Like that of M-Score, various Xf need to be brought into the equation to generate $X_{F\text{-Score}}$ in order to compare data not just from one year. If $X_{F\text{-Score}}$ is equal to one, it means it fits the Dechow F-Score, otherwise, it fails to fit the model.

$$Xfscore = \frac{Xf-1}{|Xf-1|} + 2 \tag{2}$$

Based on this, the Validity is described below, for which Nc represents the number of fraudulent companies whose $X_{\Delta M\text{-Score}}$ and $X_{F\text{-Score}}$ is 1 and Nt represents the total numbers of US-listed Chinese fraudulent companies.

$$Validity = (\sum_{n=1}^{Nc} 1)/Nt \tag{3}$$

Table 13. *Luckin Coffee's XF-Score is based on adjustment on benchmark of F-Score

US-listed Chinese Company	XΔM-Score	XF-Score	Fraud Period
Universal Travel Group (UTA)	1	0	2010
Focus Media Holding Limited (FMCN)	1	0	2011
ShengdaTech Inc. (SDTH)	0	1	2008
Luckin Coffee (LKNCY)	1	1	2019-2020
Longtop Financial Technology (LFT)	1	0	2009-2010
China Northeast Petroleum Holdings Limited (NEP)	1	0	2009-2010
TAL Education Group (TAL）	1	0	2019
Validity	**85.71%**	**28.57%**	

The Validity of M-score is 85.71% while that of F-score is 28.57%. It could be that the former is more likely to be affected by the lack of data for certain periods. For instance, some companies may not have the data for the year when they first entered the market. Despite this, the ability to prevent fluctuations in the F-score's data is still not as strong as that of M-score.

6   Fraud Prevention

1. Increase the default cost of financial fraud and improve the information disclosure system.

2. Strengthen risk management of related party transactions and improve corporate governance.

3. The M-score considers the consistency of the data between years when it comes to calculating the probability of financial fraud. For instance, if the data is consistent between years, then the score is more likely to predict financial fraud.

4. To create a more uniform global financial system, establish accounting standards and regulations that will benefit companies from different countries. This will also help lower the cost of doing business in each region.

7   Limitations

Despite the research and answers we conducted, there are few limitations.

1. The sample size of fraudulent US-listed Chinese firms is relatively small, despite the fact that a certain amount of data of fraudulent Chinese firms is not applicable in this research.

2. Our target samples span many industries. Therefore, it is not useful to generate a specific validity of the scores in certain areas. Yet, it is possible that M and F-Score will apply to US-listed Chinese companies for certain industry.

3. Not all of the companies that we compared in beverage & food industry are listed in US and few are listed in Hong Kong, despite that the data needed in calculation of M and F-Score will not affect the final results.

4. Certain firms' full data is missing in their financial statement, which results in a null of certain numbers in calculation.

8   Conclusion

Based on the data collected, the M-Score of Chinese companies in the US is 85.71% higher than that of Aghghaleh, which is for American companies of 73.17%. However, due to the limited number of Chinese companies in the country, the data might not provide a clear picture of the common characteristics of all Chinese companies.

Although the data collected is mainly used for search purposes, we also introduce an industry benchmark to the discussion. The validity of the data is determined beyond a single M-score.

The validity of the F-score is not widely acknowledged due to its lack of consistency and its inability to work in every case. This means that it might not be able to provide a clear picture of the characteristics of Chinese companies in the US. Also, given the 28.57% correctness of the data, it might cause a significant disparity between the figures provided by Aghghaleh and the F-score.

The study of financial fraud should be improved due to the increasing number of these types of activities.

Acknowledgement

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