Evaluation Model Optimization and Algorithm Design for Financial Transformation of Medicine Business Enterprises based on Data Mining

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Abstract—Under the influence of the COVID-19 pandemic, medicine industry has attracted much attention in China. This paper analysis the industry chain of the medicine industry. Based on data mining, the financial index analysis of the two leading pharmaceutical companies in Jointown and Shanghai Pharmaceuticals was carried out. Finally, through the SPSS software, using the principal component analysis method to optimize the financial transformation evaluation model and algorithm design.

Keywords-Medicine Business; Index Analysis; Evaluation Model Optimization

1. Introduction

Medicine business is known as the medicine distribution industry. For a long time, the medicine business has not received attention from people [1]. After the outbreak of the COVID-19 pandemic, medicine business has gradually attracted attention and demand [2]. However, there are the long-term development limitations, such as the middle of the industrial chain, and poor innovation [3]. Due to the simultaneous extrusion of upstream and downstream enterprises, the economic benefits and development quality of medicine business enterprises are not high [4]. Through data mining of medicine business enterprises, we can quickly understand the development of the medicine business industry, which is of great significance for promoting the profit and efficiency of the medicine business industry. At the same time, through SPSS software, the principal component analysis method is used to optimize the financial transformation evaluation model and design the algorithm to improve the analysis efficiency of financial transformation development.

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2. The Position of Medicine Business in the Industry Chain

Medicine business is an intermediate industry in the industrial chain, connecting medicine manufacturers and medicine consumer markets [5]. The competition among medicine business enterprises in China is relatively large [6]. They are more dependent on upstream and downstream enterprises. As shown in the figure 1, in the medicine industry, medicine production enterprises such as raw materials and chemical preparations belong to the medicine manufacturing industry. Medicine distribution enterprises such as medicine wholesales belong to the medicine business. Medicine terminal enterprises such as medical institutions belong to the medicine consumer markets.

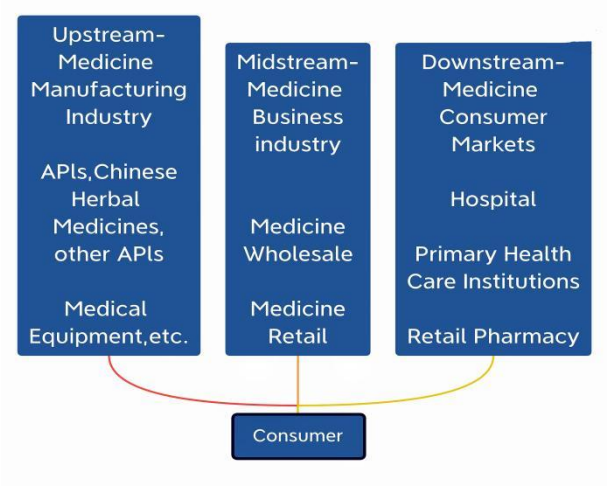

Figure 1. Medicine Upstream and Downstream Industries

Medicine business is squeezed by upstream and downstream [7]. The influence of upstream mainly includes two ways. First, the number of medicine business enterprises is increasing, and the competition is increasing. Medicine business enterprises lose the initiative when transacting with medicine manufacturing enterprises [8]. Medicine manufacturing enterprises are unwilling to give too many concessions to medicine business enterprises, squeezing the profits of some medicine business enterprises. Second, medicine manufacturers occupy part of the medicine sales market. Under the guise of conducting clinical trials, some upstream manufacturers supply directly to downstream hospitals [9]. They divide up the profits from production and distribution. The squeeze of production enterprises makes the income of medicine business enterprises not improve, but is divided up.

The impact of downstream on medicine business enterprises is mainly due to the prevalence of hospitals profiting from drug revenue. In the income composition of hospital, the medicine income accounts for the majority proportion. For its own development, the hospital must work hard to increase the income of medicines. So it constantly lower the purchase price of medicines to gain profits. The end of drug wholesale is mainly hospitals and other medical institutions, so they have a monopoly in the drug market. In order to improve competitiveness and sell more medicines, medicine business enterprises can only sell medicines at low prices.

3. Case Analysis of Medicine Business Enterprises based on Data Mining

The number of medicine business enterprises in China is increasing, but the leading enterprises of Shanghai Pharmaceutical and Jointown still occupy a large scale. Based on data mining, this paper uses four first-level financial indicators of enterprise profitability, solvency, operation and growth, and 15 second-level indicators, to analysis Jointown and Shanghai Pharmaceutical. It can quickly understand the financial transformation and development of the medicine business industry.

3.1 Jointown Enterprise

Jointown Enterprise was established in 1985. Its main business projects include wholesale, retail chain, logistics and distribution of western medicine, traditional Chinese medicine. It has been selected as one of the Top 500 Chinese Enterprises for 6 consecutive years.

3.1.1 Analysis of Enterprise Profitability

The profitability capability indicator of Jointown from 2012 to 2021 are sorted out, including return on equity, gross profit margin, net interest rate, as shown in Table 1 below.

Table 1. Profitability Capability Indicators of Jointown Enterprise

PCI	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
ROE	11.25	15.9	9.54	7.45	10.75	8.29	8.42	8.1	9.83	9.68
GPM	8.21	8.97	8.75	8.63	8.44	7.84	7.57	7.1	6.67	6.41
NIR	2.76	3.05	1.79	1.59	1.99	1.47	1.42	1.38	1.41	1.4

From 2012 to 2021, the gross profit margin of Jointown showed an upward trend. The net interest rate of Jointown is on the rise. It means that the profitability has increased. From 2012 to 2017, the ROE of Jointown fluctuated greatly. From 2018 to 2021, the ROE increased. It means that the enterprise is gradually improving its profitability.

3.1.2 Analysis of Enterprise Solvency

The solvency capability indicator of Jointown from 2012 to 2021 are sorted out, including current ratio, quick ratio, cash flow ratio, assets and liabilities, as shown in Table 2.

Table 2. Solvency Capability Indicators of Jointown Enterprise

SCI	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
CR	1.238	1.289	1.282	1.289	1.416	1.273	1.296	1.358	1.309	1.437
QR	0.993	1.001	0.976	0.975	1.019	0.871	0.909	0.927	0.883	0.937
CFR	-0.052	0.067	0.06	0.028	-0.033	0.017	0.021	-0.01	0.012	-0.05
AAL	68.92	68.31	69.12	69.43	62.46	68.99	69.78	67.61	71.29	67.33

The current ratio of Jointown from 2012 to 2021 shows that its short-term solvency is weak. Except for the 2017 and 2020, the quick ratio was greater than 1, all the other years were less than 1. It means that the solvency was weakened. The cash flow ratio of Jointown was low. The values in 2012, 2014, 2017 and 2021 were even negative. It means that the short-term solvency of Jointown was weak. The assets and liability ratio of Jointown was greater than 60%. So the enterprise has relatively high financial risks.

3.1.3 Analysis of Enterprise Operation

The operating capacity indicators of Jointown Enterprise from 2012 to 2021 are sorted out, including accounts receivable turnover days, total asset turnover, inventory turnover, accounts receivable turnover, as shown in Table 3 below.

Table 3. Operational Capability Indicator of Jointown Enterprise

OCI	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
ARTD	87.92	78.46	81.76	78.24	65.82	57.6	52.77	43.8	36.02	27.9
TAT	1.099	1.459	1.444	1.468	1.629	1.73	1.749	1.92	2.002	2.22
IT	5.93	6.997	6.494	6.107	6.063	6.21	6.355	6.79	6.881	6.94
ART	3.071	4.588	4.403	4.601	5.47	6.25	6.821	8.23	9.996	12.9

For accounts receivable, the turnover of Jointown is in a downward trend, the turnover days are gradually increasing. It can be seen that Jointown is able to manage accounts receivable. For inventory, the inventory turnover ratio of Jointown is basically greater than 6. Overall, its inventory management efficiency is still very good. The total asset turnover rate is in a downward trend. So the utilization efficiency of total assets needs to be enhanced.

3.1.4 Analysis of Enterprise Growth

The growth capability indicators of Jointown Enterprise from 2012 to 2021 are sorted out, including total operating income, attributable net profit, total operating income increased year-on-year, attributable net profit to year-on-year increase, as shown in Table 4 below.

Table 4. Growth Capability Indicators of Jointown Enterprise

GCI	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
TOI	920.9	1109	995.0	871.4	739.4	615.6	496.9	410.7	334.4	295.1
ANP	24.05	30.75	17.27	13.41	14.46	8.767	6.945	5.607	4.779	4.127
TOIIY	14.66	11.42	14.19	17.84	20.12	24.13	20.75	22.82	13.32	18.8
ANPTYI	12.31	78.1	28.79	-7.26	64.87	26.23	23.87	17.32	15.8	10.31

In 2021, the attributable net profit of Jointown is 2.405 billion yuan, the rest of the year has shown an upward trend. The total operating income increased by 14.66% year on year, and the net profit attributable to the year-on-year growth was 12.31%. From 2012 to 2021, this indicator is a positive number. It means that the total operating income of Jointown is increasing and still very promising. Except for 2018, which was negative, other years were positive. It means that the net profit of Jointown has generally increased year by year.

3.2 Shanghai Pharmaceutical Enterprise

Shanghai Pharmaceutical Enterprise is a state-controlled medicine industry group. The main business projects are the medicine R&D and manufacturing, distribution and retail. The enterprise ranks second in the medicine industry.

3.2.1 Analysis of Enterprise Profitability

The profitability capability indicator of Shanghai Pharmaceutical Enterprise from 2012 to 2021 are sorted out, including return on equity, gross profit margin, net interest rate, as shown in Table 5 below.

Table 5. Profitability Capability Indicators of Shanghai Pharmaceutical Enterprise

PCI	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
ROE	9.5	10.34	10.12	10.34	10.73	10.39	9.98	9.67	8.75	8.62
GPM	13.49	14.3	14.37	14.18	12.78	11.79	12.13	12.34	13.1	13.6
NIR	3.33	2.92	2.59	2.8	3.1	3.17	3.19	3.24	3.32	3.61

From the view of gross profit margin, this indicator of Shanghai Pharmaceutical from 2017 to 2021 is on the rise. The net interest rate of Shanghai Pharmaceutical has gradually increased in recent years. It means that the profitability of enterprise has increased. The ROE of Shanghai Pharmaceutical has fluctuated greatly in the first six years, and increased from 2018 to 2021. It means that the enterprise is gradually improving its profitability.

3.2.2 Analysis of Enterprise Solvency

The solvency capability indicator of Shanghai Pharmaceutical Enterprise from 2012 to 2021 are sorted out, including current ratio, quick ratio, cash flow ratio, assets and liabilities, as shown in Table 6 below.

Table 6. Solvency Capability Indicators of Shanghai Pharmaceutical Enterprise

SCI	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
CR	1.268	1.22	1.315	1.358	1.383	1.466	1.41	1.52	1.654	1.755
QR	1.008	0.947	0.981	0.993	1.035	1.067	1.027	1.111	1.226	1.311
CFR	0.031	0.078	0.081	0.046	0.053	0.047	0.034	0.042	0.038	0.052
AAL	64.41	63.31	63.96	63.4	57.95	55.48	54.52	51.66	48.5	45.76

The current ratio of Shanghai Pharmaceutical is less than 2, indicating that the short-term solvency is weak. Except from 2018 to 2020, the quick ratio of enterprise is less than 1, the other years are greater than 1. Its solvency needs to be strengthened. The cash flow ratio of Shanghai Pharmaceutical is relatively low, its short-term solvency needs to be improved. The assets and liability ratio was between 40% and 60% before 2018. From 2018 to 2021, it was greater than 60%. So it has relatively high financial risks in recent years.

3.2.3 Analysis of Enterprise Operation

The operating capacity indicators of Shanghai Pharmaceutical Enterprise from 2012 to 2021 are sorted out, including accounts receivable turnover days, total asset turnover, inventory turnover, accounts receivable turnover, as shown in Table 7 below.

Table 7. Operation Capability Indicators of Shanghai Pharmaceutical Enterprise

OCI	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
ARTD	95.75	94.4	86.88	84.78	84.42	80.83	79.76	73.98	69.53	66.7
TAT	1.03	1.341	1.414	1.438	1.478	1.538	1.522	1.532	1.457	1.379
IT	5.775	6.718	6.403	6.456	6.776	6.762	6.581	6.726	6.535	6.494
ART	2.82	3.813	4.143	4.247	4.265	4.454	4.514	4.866	5.177	5.397

As for accounts receivable, the turnover of Shanghai Pharmaceutical has gradually decreased. The turnover days has gradually increased. The management ability of accounts receivable turnover of Shanghai Pharmaceutical needs to be improved. As for inventories, the inventory turnover ratio did not change much, and it was basically greater than 6. Overall, its inventory management efficiency is still very good. As for the total asset turnover rate, from 2012 to 2021, the total asset turnover rate of Shanghai Pharmaceutical is in a gradual downward trend, indicating that its utilization efficiency of total assets needs to be enhanced.

3.2.4 Analysis of Enterprise Growth

The growth capability indicators of Shanghai Pharmaceutical Enterprise from 2012 to 2021 are sorted out, including total operating income, attributable net profit, total operating income increased year-on-year, attributable net profit to year-on-year increase, as shown in Table 8 below.

Table 8. Growth Capability Indicators of Shanghai Pharmaceutical Enterprise

GCI	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
TOI	1610	1919	1866	1591	1308	1208	1055	924	782	681
ANP	44.84	44.96	40.81	38.8	35.2	32	28.8	25.9	22.1	20.5
TOIIY	14.72	2.86	17.27	21.6	8.35	14.5	14.2	18.1	14.9	24
ANPTYI	24.49	10.17	5.15	10.2	10.1	11.1	11.0	17.1	7.83	0.52

The total operating income of Shanghai Pharmaceutical in 2021 is 161 billion yuan. This indicator has been increasing from 2012 to 2021. Net profit attributable about 4.484 billion yuan in 2021, and has been rising since 2012. In 2021, the total operating revenue increased by 14.72% year on year. It means that the development prospects of Shanghai Pharmaceutical are great. The net profit in 2021 increased by 24.49% year on year. The indicator has been positivist from 2012 to 2021.

4. Financial Transformation Evaluation Model Optimization and Algorithm Design

Based on the principal component analysis method, the data of Jointown and Shanghai Pharmaceutical is used to analysis the optimization of the financial transformation evaluation model. Principal component analysis can convert multiple indicators into several comprehensive indicators under the premise of losing little information. Therefore, it is used to simplify the financial transformation evaluation model and improve the analysis efficiency.

Standardize the 15 second-level indicators under the 4 first-level indicators of profitability, solvency, operational capacity, and growth capacity. As shown in the following formula (1), to eliminate the dimension between the data.

$$X_{ij} = \frac{x_{ij} - \min x_j}{\max x_j - \min x_j} \tag{1}$$

The standardized data were imported into SPSS software. The principal components with cumulative contribution rate of more than 85% were extracted by principal component analysis. According to the results of SPSS, the cumulative contribution rate of extracting 4 principal components reaches 85.207%, so it is enough to extract 4 principal components. The gravel diagram in Figure 2 below shows that after the fourth principal component, the change trend has stabilized, which also indicates that four principal components can be extracted.

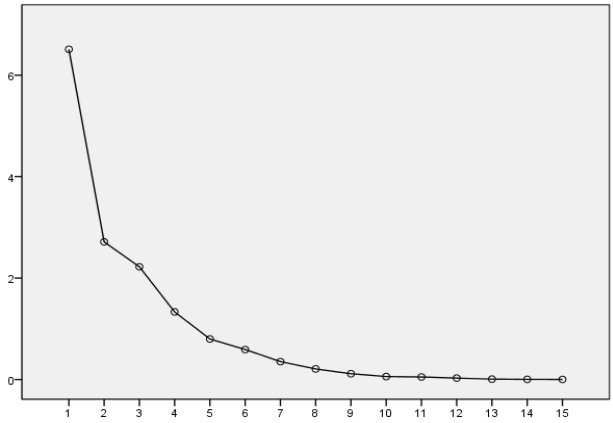

Figure 2. Gravel Diagram

According to the SPSS software, the scores of the four principal components were calculated. The variance contribution rates of the selected four principal components were obtained by the SPSS results. The variance contribution rate of each principal component is used as a weight. A comprehensive evaluation function is constructed, as shown in formula (2).

$$F = \alpha_1 y_1 + \alpha_2 y_2 + \ldots + \alpha_m y_m \tag{2}$$

Among them, y1, y2, y3, and y4 are the scores of the four principal components. α1, α2, α3, and α4 are the corresponding weights of each principal component. Calculate the comprehensive score, and draw it as a line graph, as shown in Figure 3 below.

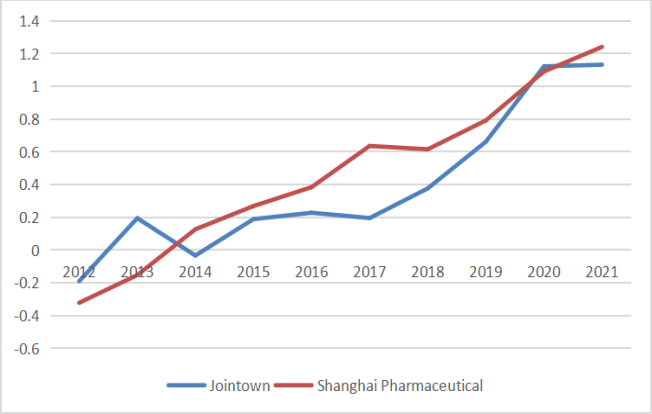

Figure 3. Comprehensive Score Line Chart

Among the principal components extracted by SPSS, the principal components mainly include indexes with large absolute values and equal in size of coefficients among the 15 indexes. According to the coefficients of the 15 indicators in the SPSS, the principal component y1 contains five indicators of x4, x8, x11, x12, and x13. The principal component y2 contains one indicator of x5. The principal component y3 contains two indicators of x1 and x3. The principal component y4 contains one indicator of x6. Therefore, the 15 indicators of the financial transformation evaluation model can be simplified into 9 indicators to achieve the optimization of the system. And as shown by the line chart in Figure 3, the evaluation results of the optimized financial transformation evaluation model are the same as before optimization. The financial transformation development level of Jointown and Shanghai Pharmaceutical is on the rise. The optimized financial transformation evaluation model is shown in Table 9 below.

Table 9. The Optimized Financial Transformation Evaluation Model

First-Level Indicator	Second-Level Indicators
PCI	ROE NIR
SCI	CR QR CFR
OCI	ARTD ART
GCI	TOI ANP

5. Summary and Outlook

In the above, the industrial chain of the medicine business industry was sorted out. Through data mining, the financial index analysis of Jointown and Shanghai Pharmaceutical, was carried out in four aspects. Through SPSS software, the principal component analysis method is used to optimize the financial transformation evaluation model to improve the analysis efficiency. From the perspective of the external environment of the industry, medicine business

industry plays a role in linking the medicine manufacturing industry and the medicine consumer markets. It is vulnerable to being squeezed by upstream and downstream enterprises to divide up part of its profits. From the perspective of the industry, the two leading enterprises have a good overall business situation. Their profitability is relatively strong. However, the short-term and long-term solvency is weak. The two leading enterprises still need to continuously improve the efficiency of asset utilization. The total operating income of each enterprise is increasing year by year, and the development prospect is great.

In general, medicine business enterprises still have a lot of profit margins. The pursuit of health is a new driving force for the development of medicine business industry. The medicine business industry should actively cooperate with upstream and downstream, develop more new drugs with clinical value. While protecting public health, it will promote the prosperity and development of the financial transformation of the medicine industry.

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