Academic Journal of Engineering and Technology Science
ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

Evaluation of Enterprise Investment Value Based on Principal Component Analysis: Information Transmission, Software and Information Technology Services in China

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ABSTRACT. *The paper selected the relevant data of 302 listed companies in information transmission, software and information technology services from 2014 to 2018 in China, used principal component analysis method to analyze the investment value, obtained the ranking of investment value, and compared it with the market performance to determine the investment strategy. Faced with the increasingly mature development of China's information service industry, how to correctly measure enterprise value and judge investment opportunities has become the key to the success or failure of many investors. Therefore, it is of great practical significance to analyze the investment value of listed companies in China's information service industry.*

KEYWORDS: *Investment value, Principal component analysis, Information transmission, software and information technology services*

1. Introduction

The information industry is a pillar industry of the national economy. In the early stage of informatization development, Chinese informatization and software industry still had problems such as small scale, low quality, poor independent innovation capability, insufficient development capability, unreasonable industrial structure and product structure, etc., resulting in relatively lagging development. However, in recent years, with the substantial increase in R&D investment, the significant improvement in technological level, the increasingly fierce competition in the international market, and benefiting from the national key cultivation, macro industry and economic policy support, Chinese information transmission, software and information technology service industry has formed a basic pattern of healthy development and coordinated promotion. The overall innovation capability and industrial development level have reached the world's advanced level, which

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

provides strong support for the sustainable development of the economy and society. According to the latest data announced by the National Bureau of Statistics in 2019, the GDP for 2018 exceeded 13.63 trillion dollars, achieving a year-on-year growth of 6.6%. Among them, the information transmission, software, and information technology service industries contributed 491.1 billion dollars, a year-on-year increase of 30.7%, achieving an absolute leader in growth and becoming a new growth point for the national economy in the past two years. Communication networks and information technology equipment are the material foundation and main driving force of national informatization. The popularization of information technology and the wide application of information products will promote the transformation of social production and lifestyle, and the transformation of the latter will counteract the former, accelerating information technology Self-innovation.

Facing the current favorable environment, how to seize the opportunity to invest has become the focus of attention of the investment community and even ordinary people. As far as investors are concerned, how to allocate their own funds, choose the most promising industries in different industries, choose the best companies in the same industry to invest in, and meet their own investment needs requires objective and credible analysis as a basis. Faced with the current status and development prospects of listed companies in the information transmission, software and information technology service industries in China, how to master a lot of information is the key to the success of investors' investment, so it has important practical significance to analyze the investment value of listed companies in China's information transmission, software and information technology service industries.

2. Establishment of comprehensive evaluation index system for investment value

2.1 Index determination principle

The comprehensive evaluation of the internal value of listed companies should follow the principles of authenticity and effectiveness, scientificity and practicality, systematic comprehensiveness and feasibility. It must be logically clear, practical, based on science, and the scope of the setting must be adapted to reality. And try to use concise, generalized, and holistic indicators. The indicators not only have correlations, but also independently reflect the information contained in the research object.

2.2 Construction process of index system

The basic process of constructing the investment value indicator system of listed companies in the information transmission, software and information technology service industries is as follows: Firstly, clarify the primary and secondary indicators, and make a reasonable explanation for the reasons for selecting the secondary

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

indicators; Then secondary level indicators are subdivided; Finally, design third-level indicators and analyze and explain them.

The analysis of the investment value of listed companies in the information transmission, software and information technology service industries should include the analysis of the macro environment, the industry's environment and the company's operating conditions. Because the macroeconomic analysis process is relatively complicated, there are many indicator factors involved, and the development of the industry will not change significantly in a period of time, so the indicator system of this article is only analyzed by the micro data of the listed companies at a certain time. Unquantifiable indicators are not considered for the time being.

In previous studies, scholars usually regarded profitability, solvency, operational capabilities and development capabilities as the main factors affecting the investment value of listed companies. Therefore, this article incorporates profitability, development ability, debt repayment ability, and operation ability into the investment value indicator system. Profitability can also be called the capital appreciation ability of a company. Only companies with strong profitability will have excess funds to give back to investors, and the interests of investors will be protected to attract more investors to invest. The solvency of an enterprise is related to its survival and long-term development. If the company has a strong debt repayment ability, it means that the company is well developed and financially well. On the contrary, if the company's debt solvency is weak, it means that the company's capital is not running well and there is a problem with the capital. Therefore, companies with strong solvency are more able to win the trust of investors. The ability to develop an enterprise means the ability of an enterprise to expand and also implies the future development of an enterprise. Therefore, the stronger the company's ability to grow, the stronger the company's ability to increase income year by year, and the higher the investor's income, which will attract more investors to invest. The analysis of the company's operating capability is mainly reflected in the analysis of the company's asset management capabilities, which is mainly reflected in the turnover and turnover rate of each asset. If the turnover rate is high, the company's asset management capability will be strong, and the operation capability will be strong. The operational capability of a company can help investors judge the safety and stability of the company's finances, and facilitate investors to make correct investment decisions.

And because the main research objects of this article are all listed companies in the information transmission, software and information technology service industries, it is necessary to include R&D and innovation capabilities into the index system. R&D and innovation capabilities are undoubtedly a matter of life and death for high-tech companies. In previous studies, the importance of R&D and the level of resources actually paid for R&D were usually measured from the perspective of R&D investment. Having R&D and innovation capabilities higher than peers means stronger core competition of the company.

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

Therefore, this paper selects profitability, solvency, development capability, operating capability and R&D capability as the secondary indicators, and through screening, selects a total of 14 representative third-level indicators to measure. Table 1 shows these indictors.

Table 1 Third-Level Indicator System

	Secondary indicators	Third-level indicators
Value of investment in information transmission, software and information technology services	**Profitability**	Return on total assets
		Return on net assets
		EBIT margin of total assets
		Return on invested capital
	Operational capability	Turnover rate of liquid assets
		Turnover rate of total assets r
		Turnover rate of net assets
	Development ability	Growth rate of total assets
		Growth rate of net assets
		Growth rate of net assets per share
	Solvency	Equity ratio
		Long-term debt-to-equity ratio
	R & D capabilities	Percentage of R&D personnel
		R&D investment as a percentage of operating income

The price-to-book ratio is an indicator often used by investors for investment analysis. Under normal circumstances, stocks with lower P/B ratio have higher investment value. P/B ratio means the ratio of the stock price to the company's net assets. Therefore, the low P/B ratio means that the investment risk is small. In the event of a listed company's failure, more costs can be recovered when it is liquidated. Companies with high P/B ratios indicate that they are favored by investors and are optimistic about future development. Therefore, this article will use the P/B ratio at the end to compare and test the accuracy of the comprehensive indicators of investment value.

2.3 Data source

This article uses the China Securities Regulatory Commission's 2012 industry classification of listed companies as the standard, and selects 302 listed companies in the information transmission, software and information technology service industries of Shanghai and Shenzhen stocks as samples to evaluate the investment value of this listed company. We collect the financial index data and non-financial index data of the annual reports of each listed company from 2014 to 2018, and make the data into a table according to the index system. All the data in this article comes from CSMAR database. Due to limited space, specific data are not listed here.

This paper uses STATA14.0 for data processing, eliminates samples with missing key indicator values, uses SPSS26.0 statistical analysis software to select principal components based on the cumulative variance contribution rate, analyzes

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

to obtain the comprehensive principal component score, and then uses the calculation to obtain the comprehensive principal component value. Finally, we carry out research and analysis on the evaluation results, and draw the conclusion of this article.

3. Principal component analysis process

3.1 Sample feasibility test

Table 2 KMO and Bartlett Test

Kaiser-Meyer-Olkin measure of sampling adequacy		.673
Bartlett's spherical test	**Approximate chi-square**	12588.944
	Freedom	120
	Significance	.000

It can be seen from Table 3 that the KMO value is 0.673, which is obviously greater than 0.5, indicating that the sample size of this article is sufficient. In addition, the approximate chi-square value is 12588.944, the degree of freedom is 120, and the significance probability value is zero, which is less than 0.5, which is sufficient to show that there are common factors in the overall correlation matrix.

Table 3 Common Factor Variance

Indicator	Initial	Extraction
Growth rate of total assets	1.000	.783
Growth rate of net assets	1.000	.972
Growth rate of net assets per share	1.000	.894
Turnover rate of liquid assets	1.000	.910
Turnover rate of total assets r	1.000	.975
Turnover rate of net assets	1.000	.932
Percentage of R&D personnel	1.000	.769
R&D investment as a percentage of operating income	1.000	.771
Return on total assets	1.000	.951
Return on net assets	1.000	.883
EBIT margin of total assets	1.000	.965
Return on invested capital	1.000	.974
Equity ratio	1.000	.997
Long-term debt-to-equity ratio	1.000	.996

Table 3 shows the common factor variance. The greater the variance of the common factor, the stronger the explanatory power of the principal component analysis model for the original variables. It can be seen from the above table that the minimum value of the common factor variance is 0.769 and the maximum value is

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

0.997. It can be seen that the principal component analysis model used in this paper has a strong explanatory power for the original variables.

Table 4 Explanation of total variance

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	Variance Percent	Accumulation %	Total	Variance Percent	Accumulation %	Total	Variance Percent	Accumulation %
1	3.950	28.213	28.213	3.950	28.213	28.213	3.754	26.817	26.817
2	2.842	20.298	48.510	2.842	20.298	48.510	2.821	20.151	46.968
3	2.591	18.505	67.016	2.591	18.505	67.016	2.646	18.897	65.865
4	1.931	13.796	80.812	1.931	13.796	80.812	2.014	14.384	80.250
5	1.457	10.410	91.221	1.457	10.410	91.221	1.536	10.972	91.221
6	.462	3.301	94.523						
7	.332	2.371	96.894						
8	.178	1.269	98.163						
9	.147	1.048	99.210						
10	.042	.300	99.511						
11	.032	.231	99.742						
12	.023	.167	99.909						
13	.010	.070	99.979						
14	.003	.021	100.000						

This paper extracts principal components whose characteristic roots are greater than 1, and the cumulative contribution rate of each principal component needs to reach 85% or more. As shown in Table 4, there are 5 principal components with characteristic roots greater than 1, and their cumulative contribution rate reaches 91.221%. Therefore, this paper selects five principal components. Set F1 as the first principal component, and F2, F3, F4, and F5 as the second principal component, the third principal component, the fourth principal component, and the fifth principal component, respectively. The following will study the rotating component matrix.

3.2 Determination of ingredients

As shown in Table 5, in the first principal component, the return on total assets, return on net assets, EBIT margin of total assets, and return on invested capital have higher loads, and their loads are 0.973, 0.916, and 0.981, respectively. And 0.985. Therefore, the first main component mainly includes return on total assets, return on net assets, EBIT margin of total assets, and return on invested capital. Since it reflects the profitability of an enterprise, the first principal component is named profitability.

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

Table 5 Rotated component matrix

Indicator	Component				
	1	2	3	4	5
Growth rate of total assets	.087	.018	.880	-.002	-.005
Growth rate of net assets	.014	-.011	.985	-.007	-.018
Growth rate of net assets per share	.023	.014	.945	-.013	-.022
Turnover rate of liquid assets	-.014	.954	.011	-.015	.012
Turnover rate of total assets	-.008	.987	-.006	-.008	.042
Turnover rate of net assets	-.028	.964	.018	.009	.039
Percentage of R&D personnel	.001	.079	-.033	.011	.873
R&D investment as a percentage of operating income	.039	-.006	-.004	.053	.875
Return on total assets	.973	-.013	.048	-.031	.014
Return on net assets	.916	-.008	.046	-.205	-.001
EBIT margin of total assets	.981	-.003	.029	-.029	.027
Return on invested capital	.985	-.035	.031	-.037	.018
Equity ratio	-.112	.006	-.010	.992	.035
Long-term debt-to-equity ratio	-.111	-.019	-.008	.991	.039

In the second main component, turnover rate of liquid assets, turnover rate of total assets and turnover rate of net assets have higher loads, and their loads are 0.954, 0.987 and 0.964 respectively. Therefore, the second main component mainly includes turnover rate of liquid assets, turnover rate of total assets and turnover rate of net assets. Since it reflects the operational capability of the enterprise, the second principal component is named operational capability.

In the third principal component, growth rate of total assets, growth rate of net assets, and growth rate of net assets per share are relatively high, and their loadings are 0.880, 0.985, and 0.945 respectively. Therefore, the third principal component mainly includes growth rate of total assets, growth rate of net assets, and growth rate of net assets per share. Since it reflects the development capability of the enterprise, the third principal component is named development capability.

In the fourth principal component, the equity ratio and the long-term debt-to-equity ratio are relatively high, and their loads are 0.992 and 0.991 respectively. Therefore, the fourth principal component mainly includes the equity ratio and the long-term debt-to-equity ratio. Since it reflects the solvency of the enterprise, the fourth principal component is named solvency.

In the fifth principal component, the proportion of R&D personnel and the ratio of R&D investment to operating income are higher, respectively, 0.873 and 0.875. Therefore, the fifth principal component mainly includes the proportion of R&D personnel and R&D investment to operating income. Since it reflects the company's R&D capabilities, the fifth principal component is named R&D capabilities.

In addition, according to the rotating component matrix, the expressions of five principal components can be obtained (Xi is the standardized data):

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

$$F_1=0.087X_1+0.014X_2+0.023X_3-0.014X_4-0.008X_5-0.028X_6+0.001X_7+0.039X_8+0.973X_9+0.916X_{10}+0.981X_{11}+0.985X_{12}-0.112X_{13}-0.111X_{14} \quad (1)$$

$$F_2=0.018X_1-0.011X_2+0.014X_3+0.954X_4+0.987X_5+0.964X_6+0.079X_7-0.06X_8-0.013X_9-0.008X_{10}-0.003X_{11}-0.035X_{12}+0.006X_{13}-0.019X_{14} \quad (2)$$

$$F_3=0.88X_1+0.985X_2+0.945X_3+0.011X_4-0.006X_5+0.018X_6-0.033X_7-0.004X_8+0.048X_9+0.046X_{10}+0.029X_{11}+0.031X_{12}-0.10X_{13}-0.008X_{14} \quad (3)$$

$$F_4=-0.002X_1-0.007X_2-0,013X_3-0.015X_4-0.008X_5+0.009X_6+0.011X_7+0.053X_8-0.031X_9-0.205X_{10}-0.029X_{11}-0.037X_{12}+0.992X_{13}+0.991X_{14} \quad (4)$$

$$F_5=-0.005X_1-0.018X_2-0.022X_3+0.012X_4+0.042X_5+0.039X_6+0.873X_7+0.875X_8+0.014X_9-0.001X_{10}+0.027X_{11}+0.018X_{12}+0.035X_{13}+0.039X_{14} \quad (5)$$

3.3 Weight determination

This article uses the normalization method to determine the weight of each principal component based on the contribution rate of the principal component. That is: the contribution rate of each principal component is divided by the cumulative contribution rate of each principal component. The specific weights are as follows:

Table 6 Weight Table

	F1	**F2**	**F3**	**F4**	**F5**	**Sum**
Contribution rate %	28.213	20.298	18.505	13.796	10.410	91.221
Weight	0.31	0.22	0.20	0.15	0.11	1.00

The following two conclusions can be drawn from Table 6:

① The weights of the five main components in the company's investment value are: 0.31, 0.22, 0.20, 0.15, and 0.11. That is to say, the degree of influence on the company's investment value is ranked in descending order of profitability, operating ability, development ability, debt solvency and research and development ability.

② Comprehensive expression of investment value:

$$F=0.31F_1+0.22F_2+0.20F_3+0.15F_4+0.11F_5 \quad (6)$$

Substituting the expressions (1)-(5) of each principal component into formula (6), we can get:

$$F=0.20608X_1+0.19589X_2+0.19484X_3+0.20681X_4+0.21688X_5+0.21264X_6+0.10877X_7+0.11417X_8+0.30526X_9+0.26054X_{10}+0.30787X_{11}+0.30028X_{12}+0.11725X_{13}+0.11275X_{14} \quad (7)$$

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

4. Analysis and recommendations of investment value results

Through the above analysis, the comprehensive expression (7) of investment value is obtained. Bringing the financial data of 302 information transmission, software and information technology service companies from 2014 to 2018 into (7) can get the comprehensive score of the company's investment value in each year, and the ranking is based on the comprehensive score. After excluding the companies and ST companies with missing variables, the following will analyze the comprehensive ranking in 2018 and the comparison with the price-to-book ratio ranking. See Table 7 for details.

It can be seen from the ranking in Table 7 that there is a certain difference between the investment value ranking and the P/B ratio ranking of listed companies obtained by the principal component analysis method in this article. The difference indicates that some companies have stocks whose intrinsic value is overvalued or undervalued. After comparative analysis, investors can identify companies with higher investment value.

Due to space limitations, this article only lists the top 12, midstream 12, and bottom 12 companies in terms of comprehensive value. The top 12 companies in terms of comprehensive investment value are: Shanghai Ganglian and Wanxing Technology, Zhengyuan Wisdom, Geer Software, Dash Intelligence, Yonyou Networks, Jiangsu Cable, Shengxunda, Anshuo Information, Sitech, Heren Technology, Silk Road Vision. After comparative analysis with market performance, it is also found that, except for the comprehensive rankings of Wanxing Technology, UFIDA, Anshuo Information, and Heren Technology, which are similar to the market performance rankings, the investment value of the other eight companies is underestimated, indicating that they have high investments. Value, investors can focus on.

For companies whose comprehensive value is in the midstream, investors often do not pay too much attention to them in market analysis, and their development potential is easy to overlook. Among the twelve companies in the midstream, the rankings of COSCO Haike, Kunlun Wanwei, NavInfo, and Sinnet are similar to the market performance rankings, and the value of the remaining eight companies such as Bank of China, 2345, and Philips Underestimated by the market, investors can pay proper attention and seize the right time to invest.

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

Table 7 Comparative analysis table of 2018 company comprehensive ranking and P/B ratio ranking

Stock code	Short for stock	Comprehensive value	Comprehensive value ranking	P/B ratio	P/B ratio ranking
300226	Shanghai Steel Link	22.9058	1	2.92867	106
300624	Wanxing Technology	14.2136	2	7.40918	9
300645	Positive wisdom	13.6635	3	3.2858	84
603232	Geer software	13.5347	4	3.13175	97
002421	Dashi smart	13.0361	5	2.24146	151
600588	Use a friend network	12.7048	6	5.33848	32
600959	Jiangsu Cable	12.4002	7	0.9143	240
300518	Shengxunda	12.3168	8	1.83264	185
300380	Asus Information	12.2415	9	4.63847	39
300608	Stetch	11.7203	10	2.56537	131
300550	And Ren Technology	11.6276	11	7.78722	8
300556	Silk Road Vision	11.6261	12	3.89774	64
002401	COSCO Haike	5.87677	114	3.06462	100
300020	Yinjiang shares	5.85049	115	1.29726	218
300559	Jiafa Education	5.80488	116	5.98146	23
300418	Kunlun Wanwei	5.76766	117	2.7846	116
300523	Chen'an Technology	5.76503	118	6.48895	15
002195	2345	5.72069	119	1.75715	190
603602	Cross-sectional communication	5.63746	120	4.53156	46
300287	Philips letter	5.57253	121	1.43379	209
002405	Four-dimensional diagram new	5.56141	122	2.4959	133
300682	Longxin Technology	5.50611	123	5.17774	34
300383	Halo New Net	5.47848	124	2.59923	130
300579	Digital authentication	5.42061	125	4.45651	48
600850	East China Computer	1.70108	233	2.66829	123
000948	Nantian information	1.69553	234	1.32616	216
300561	Huijin Technology	1.60842	235	3.24788	88
002354	God's entertainment	1.53374	236	2.08403	162
603636	Nanwei Software	1.50136	237	2.85949	112
002517	Yingying Network	1.45528	238	1.09959	235
002261	Tovey information	1.41002	239	1.86101	184
600358	National Travel Union	1.39485	240	3.26859	86
002380	Koyuan wisdom	1.3357	241	1.21186	229
000997	Newland.	1.14133	242	2.79705	115
600718	Dongso soft group	1.07068	243	1.59171	198
300350	Hua Pengfei	0.750562	244	2.39104	140

Among the twelve companies at the bottom of the comprehensive value ranking, with the exception of Huijin Technology and China National Travel Service, which squeezed into the top 100 in the market performance, the remaining ten companies ranked in the middle and low positions in the market investment order. The results also further verify the correctness and scientificity of the research method in this article. The ranking result is effective and feasible, and can be used as a reference for investor decision-making.

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

5. Conclusion

5.1 Analysis conclusion

This paper constructs an investment value evaluation index system for listed companies, and conducts empirical research with 302 listed companies in the information transmission, software and information technology service industries as samples. The principal component analysis method is used to evaluate the comprehensive investment value of listed companies in the information service industry. Through analysis, this research has reached the following preliminary conclusions:

5.1.1 Analysis index

Through the five business capabilities of profitability, solvency, operational capabilities, development capabilities, and R&D capabilities, the investment value of listed companies in the information service industry can be effectively analyzed. This paper selects fourteen financial and non-financial indicators from the five operating capabilities to establish an investment value evaluation system. The indicators include return on total assets, return on net assets, EBIT margin of total assets, return on invested capital, turnover rate of liquid assets, turnover rate of total assets, turnover rate of net assets, growth rate of total assets, growth rate of net assets, growth rate of net assets per share, the equity ratio, the long-term debt-to-equity ratio, the proportion of R&D personnel and the ratio of R&D investment to operating income.

5.1.2 Analysis method

Principal component analysis method is used to obtain a comprehensive ranking of investment value. And P/B ratio is introduced for comparative analysis, to find whose investment value is underestimated among the listed companies, for investors to refer to when making decisions. The principal component analysis method is more accurate in evaluating the intrinsic value of listed companies, and the investment value evaluation results given are more in line with the actual situation of listed companies in the information service industry. This shows that the principal component analysis method is a relatively objective and feasible method to comprehensively analyze the investment value of listed companies. The quantitative comprehensive evaluation results it gives can be used as references for investors in investment decisions.

5.2 Deficiencies

The financial data used in this article all come from the annual reports disclosed by listed companies, and these data are usually at risk of whitewashing. Secondly,

ISSN 2616-5767 Vol.3, Issue 7: 132-144, DOI: 10.25236/AJETS.2020.030714

due to the timeliness of financial statements, the company's temporary dynamics cannot be clearly reflected in the annual report. These objective factors will affect the authenticity of the statements, and then affect the reliability of the selected indicators and the effectiveness of the analysis. Finally, it is too one-sided to judge the validity of the comprehensive index of investment value established in this article based on P/B ratio.

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