ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

Comprehensive Evaluation of Listed Companies in the Automotive Industry

Yuling Liu[1, a]

[1]Department of Economics, Jinan University, Guangzhou, China

[a]mixiu1128@outlook.com

Abstract

This paper collects the operating index data of 12 listed companies in China's auto industry. Based on the factor analysis of the psych package, the financial indicators are attributed to three common factors: profitability factor, solvency factor and development capability factor, and calculate each company. The comprehensive factor scores provide a comprehensive assessment of the automotive industry. Through analysis, it is found that the top auto companies with comprehensive scores are diversified and can lead other companies in many aspects. In general, the gap between these listed companies in the automotive industry is relatively obvious, and there are very few companies that can score high on three factors. Finally, the chart in the partial factor analysis process is shown by Shiny. I hope that through the scientific analysis of business indicators data, I will give specific recommendations for the development and improvement of the automotive industry.

Keywords

Automotive industry, comprehensive evaluation, factor analysis, Shiny.

1. INTRODUCTION

After the establishment of New China, China's automobile industry began to formally establish and develop. Its development process is roughly divided into the creation stage, the independent development stage and the opening stage. In the early 1950s to the end of the 1950s, the landmark event was the establishment of Changchun No. 1 Automobile Manufacturing Plant. It was characterized by the fact that the construction work at this stage was fully supported by the former Soviet Union, providing not only products and processes, but also Core equipment, but also undertake the task of plant design and other tasks. In the period from the late 1950s to the early 1980s, the landmark event was the establishment of the second automobile manufacturing plant. At this stage, due to the gradual deterioration of Sino-Soviet relations, China's auto industry has begun to enter an independent and self-reliant state. At this stage, China's auto industry has formed a basic industry. A wave of counterfeit and trial cars has been set up across the country, and Nanjing Auto has emerged. A relatively large-scale automobile manufacturing plant, such as a manufacturing plant and a Beijing automobile manufacturing plant. In the mid-1980s, China's auto industry entered the stage of opening up to the outside world. The landmark event was the car production company jointly invested by Beijing Automotive Industry Corporation and Chrysler, and the first complete vehicle manufacturing joint venture was born. Since then, many Chinese joint ventures have been born in the Chinese automotive industry. The characteristic of this stage is that the car industry should be the focus of development. It is necessary to introduce foreign capital to establish joint ventures and introduce foreign products, processes and management methods. The starting

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

principle is to start from a high starting point and large quantities, and the enterprises are beginning to operate according to the market mechanism.

After the 21st century, the domestic environment and the international environment have undergone tremendous changes. At this time, China's automobile industry has entered a more severe stage, with both good opportunities and deep-seated contradictions and problems exposed.

This paper attempts to use the scientific statistical method-factor analysis method to calculate the factor scores of 12 listed companies in the automobile industry based on the operating index data of 12 listed companies in China's auto industry, so as to make a comprehensive evaluation, and use Shiny to be more concise and clear. Part of the chart showing the factor analysis process.

2. BACKGROUND AND RESEARCH OBJECTS

2.1. Background

After the establishment of New China, China's automobile industry began to formally establish and develop. Its development process is roughly divided into the creation stage, the independent development stage and the opening stage.

In the early 1950s to the end of the 1950s, the landmark event was the establishment of Changchun No. 1 Automobile Manufacturing Plant. It was characterized by the fact that the construction work at this stage was fully supported by the former Soviet Union, providing not only products and processes, but also Core equipment, but also undertake the task of plant design and other tasks.

In the period from the late 1950s to the early 1980s, the landmark event was the establishment of the second automobile manufacturing plant. At this stage, due to the gradual deterioration of Sino-Soviet relations, China's auto industry has begun to enter an independent and self-reliant state. At this stage, China's auto industry has formed a basic industry. A wave of counterfeit and trial cars has been set up across the country, and Nanjing Auto has emerged. A relatively large-scale automobile manufacturing plant, such as a manufacturing plant and a Beijing automobile manufacturing plant.

In the mid-1980s, China's auto industry entered the stage of opening up to the outside world. The landmark event was the car production company jointly invested by Beijing Automotive Industry Corporation and Chrysler, and the first complete vehicle manufacturing joint venture was born. Since then, many Chinese joint ventures have been born in the Chinese automotive industry. The characteristic of this stage is that the car industry should be the focus of development. It is necessary to introduce foreign capital to establish joint ventures and introduce foreign products, processes and management methods. The starting principle is to start from a high starting point and large quantities, and the enterprises are beginning to operate according to the market mechanism.

After the 21st century, the domestic environment and the international environment have undergone tremendous changes. At this time, China's automobile industry has entered a more severe stage, with both good opportunities and deep-seated contradictions and problems exposed.

2.2. Research Object

The research object of this paper is 12 listed companies in China's auto industry. The securities abbreviations are: SAIC Group, Dongfeng Motor, FAW Car, Changan Automobile, Great Wall Motor, Jianghuai Automobile, BYD, China National Heavy Duty Truck, Haima Automobile, Huatai Shares, Jinlong Automobile. And Yutong Bus. The annual output of these enterprises can

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

reach 75% of the entire automotive industry. Therefore, the 12 listed companies selected in this paper have a good representation of China's automotive industry.

3. DATASET AND EVALUATION INDEX

3.1. Dataset

The data selected in this paper are from the financial statements disclosed by 12 listed companies in the automotive industry in December 2016, and are queried from the Guotaian database and GF Securities. From the report, the main business profit, main business income, operating profit, sales gross profit margin, quick ratio and asset-liability ratio of December 2015 and December 2016 were selected, and the collected data were used to calculate 2016. Monthly profit margin of main business, growth rate of main business income and growth rate of operating profit.

When using Shiny to display the graph of factor analysis, when the radar map is drawn, the load value and factor score of each factor on the variable are normalized.

3.2. Evaluation Index

Starting from the reflection of the company's profit, debt repayment and development capabilities, the main business profit rate, main business income growth rate, operating profit growth rate, sales gross profit margin, quick ratio and asset-liability ratio were selected into 11 financial indicators. It is used to conduct factor analysis on 12 listed companies in the automotive industry, and to conduct comprehensive evaluation based on the calculated factor scores of various companies.

Table 1. Raw data for 12 listed companies in the automotive industry

Company Name	Main business profit margin	sales gross profit margin	quick ratio	asset-liability ratio	main business income growth rate	operating profit growth rate
SAIC	6.40	12.86	0.98	60.17	12.82	11.12
Dongfeng Motor	0.78	14.00	0.99	65.54	-5.08	-34.83
FAW Car	-5.11	19.75	0.69	59.72	-14.83	-1634.45
Changan Automobile	12.04	17.89	1.01	59.30	17.63	-1.35
Great Wall Motor	12.44	24.46	1.02	48.70	29.70	32.28
Jianghuai Automobile	-5.05	9.59	0.85	68.57	13.17	-73.13
BYD	5.78	20.36	0.72	61.81	29.32	88.49
China National Heavy Duty Truck	3.31	10.54	0.94	73.20	9.07	71.02
Haima Automobile	-0.21	13.62	0.55	47.02	16.90	-151.87
Huatai	1.47	13.22	0.64	54.88	14.79	217.21
Jinlong Automobile	-7.19	8.90	1.14	82.35	-18.66	-235.61
Yutong Bus	12.25	27.82	1.14	61.09	14.87	14.76

4. FACTOR ANALYSIS

After the 21st century, the domestic environment and the international environment have undergone tremendous changes. At this time, China's automobile industry has entered a more severe stage, with both good opportunities and deep-seated contradictions and problems exposed.

This paper attempts to use the scientific statistical method-factor analysis method to calculate the factor scores of 12 listed companies in the automobile industry from the operating index data of 12 listed companies in China's auto industry.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

4.1. Factor Analysis Theory

Factor analysis is a multivariate statistical research technique that combines observed variables into a few common factors, starting from the intricate but closely related internal connections between variables. It can locate potential representative factors in many observation variables, and attribute the observation variables with the same nature into a comprehensive factor, so as to reduce the number of variables. The earliest proposer of factor analysis was the British psychologist CE Spearman, who found that there is a correlation between the scores of each subject of the student, that is, if the student's academic performance is good in one subject, then the student's other subjects are studied. The results are also very good and therefore he suspects that there may be some potential public factors that influence the student's performance. The factor analysis method can be used to classify variables or samples, and is divided into Q-factor analysis and R-factor analysis. The former studies the relationship between samples, while the latter studies the relationship between variables.

The main purpose of factor analysis is to find hidden, implicit, and unobservable implicit variables that are lurking in a set of observed variables. For example, students' enthusiasm for learning can be tested from the level of student involvement in the classroom, the completion of homework and the length of extracurricular study.

Factor analysis is further divided into exploratory factor analysis and confirmatory factor analysis. The former is to speak with data, and generally does not presuppose the relationship between factors and observed variables. The latter is presupposed to know the relationship between the factor and the observed variable, that is, which factor the observed variable corresponds to, but the specific relationship is not clear. Using factor analysis in real life, you can get the importance of each comprehensive factor, then decision makers can weigh the first problem to be solved according to the importance of each comprehensive factor.

4.2. Factor Analysis Model

The factor analysis model is as follows:

$$\begin{cases} x_1 = a_{11}F_1 + a_{12}F_2 + \cdots + a_{1n}F_n + \varepsilon_1 \\ x_2 = a_{21}F_1 + a_{22}F_2 + \cdots + a_{2n}F_n + \varepsilon_2 \\ \qquad\qquad\qquad . \\ \qquad\qquad\qquad . \\ \qquad\qquad\qquad . \\ x_p = a_{p1}F_1 + a_{p2}F_2 + \cdots + a_{pn}F_n + \varepsilon_p \end{cases}$$

This model is also known as the R-type orthogonal factor model, and its matrix form is:

$$\mathrm{X} = \mathrm{AF} + \varepsilon$$

Among them:

(1). $\mathrm{X} = \begin{bmatrix} x_1 \\ x_2 \\ . \\ . \\ . \\ x_p \end{bmatrix}$, is the observable random variable, its mean vector $\mathrm{E}(X) = 0$, Covariance matrix $\mathrm{cov}(X) = \Sigma$, and the covariance matrix Σ is equal to the correlation matrix R.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

(2). $\mathrm{F} = \begin{bmatrix} F_1 \\ F_2 \\ \cdot \\ \cdot \\ \cdot \\ F_n \end{bmatrix}$ $(\mathrm{n} < \mathrm{p})$, Is an unmeasurable vector whose mean vector $\mathrm{E}(F) = 0$, and covariance matrix $\mathrm{cov}(F) = \mathrm{I}$. That is, the components of the vector are independent of each other.

(3). $\mathrm{A} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ a_{p1} & a_{p2} & \cdots & a_{pn} \end{bmatrix}$,is the factor load matrix and a_{ij} is the factor load. It can be proved mathematically that the factor load a_{ij} is the correlation coefficient between the i-th variable and the j-th factor, reflecting the importance of the i-th variable on the j-th factor.

(4). $\varepsilon = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \cdot \\ \cdot \\ \cdot \\ \varepsilon_p \end{bmatrix}$ and F are independent of each other, and their mean vector E(ε)=0, and the covariance matrix ε of ε is a diagonal matrix, that is, the components ε are independent of each other.

(5). $\mathrm{cov}(\mathrm{F}, \varepsilon) = 0$, That is, F is not related to ε; F is called a common factor or potential factor of X, $\mathrm{var}(\mathrm{F}) = \mathrm{I}_m$, That is, F_1, F_2, ..., $F_m$are irrelevant, and the variance is 1. $\mathrm{D}(\varepsilon) = \mathrm{var}(\varepsilon) = \begin{bmatrix} \sigma_1^2 & & & 0 \\ & \sigma_2^2 & & \\ & & \cdots & \\ 0 & & & \sigma_p^2 \end{bmatrix}$, That is, ε_1, ε_2, ..., $\varepsilon_p$are irrelevant, and the variances are different.

4.3. Factor Analysis

Using R language software, the factor analysis of the six business indicators of 12 listed companies in China's auto industry was carried out, and the factor comprehensive scores of each company in 2016 were calculated. The comprehensive ranking of these 12 companies was obtained objectively and scientifically.

4.3.1Verify that the observed variables to be analyzed are suitable for factor analysis

Before performing factor analysis, it is first necessary to test whether the original variables to be analyzed are suitable for factor analysis, that is, to check whether there is correlation between the observed variables. If the test results indicate that the variables are independent of each other, the factor analysis is not suitable. Conversely, if the test results show that there is a certain degree of correlation between the observed original variables, then factor analysis can be used for analysis.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

Table 2. Correlation matrix of observed data

	X1	X2	X3	X4	X5	X6
X1	1.00000	0.69052	0.34173	-0.469980	0.71310	0.470346
X2	0.69052	1.00000	0.15191	-0.510188	0.40363	-0.112875
X3	0.34173	0.15191	1.00000	0.500914	-0.17276	0.248569
X4	-0.46998	-0.51019	0.50091	1.000000	-0.60336	-0.016365
X5	0.71310	0.40363	-0.17276	-0.603360	1.00000	0.610329
X6	0.47035	-0.11288	0.24857	-0.016365	0.61033	1.000000

The correlation matrix of the above financial indicators shows that there is a high degree of positive correlation between the profitability of the main business profit rate x1 and the sales gross profit margin x2; the quick ratio of the solvency ratio x3 and the asset-liability ratio x4 There is a certain degree of positive correlation; there is a certain degree of positive correlation between the main business income growth rate x5 indicating the development capability and the operating profit growth rate x6.

In summary, there is indeed a certain degree of correlation between financial indicators.

The KMO test statistic is used to compare the simple correlation coefficient and the partial correlation coefficient between the observed variables. The range of KMO statistic is 0～1. If the value of KMO statistic is larger, the correlation between the observed original variables is stronger. Conversely, if the value of KMO statistic is smaller, the observed original variables are The weaker the correlation between them. Whether the correlation between variables determines whether it is suitable for factor analysis of the original data, the stronger the correlation between the original variables, the more suitable for factor analysis, and the weaker the correlation between the original variables, the less suitable for factor analysis. .

The commonly used KMO test statistic reference standard is as follows: If the KMO value exceeds 0.9, it means that it is very suitable for factor analysis; if the KMO value is between 0.8 and 0.9, it means that it is suitable; if the KMO value is between 0.7 and 0.8, it means Suitable; if the KMO value is between 0.6 and 0.7, it means that it is not suitable; if the KMO value is between 0.5 and 0.6, it means that it is barely suitable; and if the KMO value is less than 0.5, it means that it is not suitable.

According to the R statistical software, the KMO value of the original data is equal to 0.52, which is between 0.5 and 0.6, indicating that the factor analysis can be performed barely.

Bartlett's spheroidal test is used to test the correlation between the observed variables in the correlation matrix, that is, to test whether the variables are independent of each other. If the observed variables are independent of each other, that is, if the Bartlett's spherical test results in a correlation matrix that is a unit matrix, then analyzing the original data by factor analysis is not valid. Normally, if Bartlett's spheroidal test shows a p-value of less than 0.05, then there is a correlation between the observed variables and factor analysis can be performed.

According to the R statistical software, the Bartlett's spherical test p value of the original data is very small, close to zero. Therefore, rejecting the original hypothesis that the correlation matrix is a unit matrix indicates that there is a certain correlation between the variables, and factor analysis can be used.

Table 3. KMO and Bartlett's ball shape test results

KMO检验	KMO值	0.52
Bartlett's检验	近似Chi-Square	472.024
	自由度	15
	p值	4.626994e-91

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

4.3.2 Number selection and extraction of factors

First, through the psych package of R statistical software, draw the gravel map of the observed variables. A gravel diagram with parallel analysis can not only present the bending variation of the data eigenvalue curve, but also generate a random number matrix of the same dimension as the original matrix to determine the number of factors to be extracted.

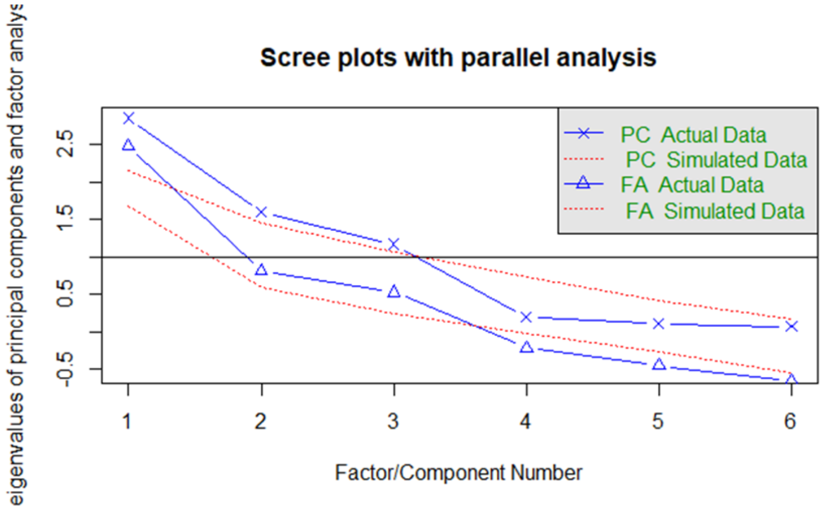


Fig 1. Scree plot

Through the gravel map, it can be judged that the number of factors that should be selected is 3.

The common factor is extracted by the maximum likelihood method again by the R statistical software, and the unrotated factor load matrix table 4 and the factor contribution table 5 are obtained. It can be seen from the table that the variance explained by the first three factors accounts for more than 89% of the entire variance, and basically can fully reflect the information of the operational indicators, so the first three factors are extracted as the common factor.

Table 4. KMO and Bartlett's ball shape test results

Index Name	Factor 1	Factor 2	Factor 3
Main business profit margin	0.80	0.55	0.12
sales gross profit margin	0.86	0.05	-0.19
quick ratio	-0.01	0.78	-0.63
asset-liability ratio	-0.70	0.27	-0.45
main business income growth rate	0.58	0.31	0.66
operating profit growth rate	-0.05	0.80	0.59

Table 5. Factor variance and its contribution (not rotated)

Factor	variance	Contribution rate	Cumulative contribution rate
Factor1	2.21	0.37	0.37
Factor2	1.72	0.29	0.65
Factor3	1.43	0.24	0.89

4.3.3 Using rotation methods to make factor variables more interpretable

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

Because the specific economic significance of the common factors represented before the rotation is ambiguous, it is decided to perform the factor rotation so that each comprehensive factor can better reflect the financial indicators. The factor load matrix after orthogonal rotation is shown in Tables 6 and Fig.2. The load value of factor F_1 on the main business profit rate x1 is 0.83, and the load value on the sales gross profit margin x2 is 0.88. Therefore, it can be considered that the factor F_1 represents the profitability of the enterprise and is an indicator reflecting the investment income of the enterprise; The load value of F_2 in the main business income growth rate x5 is 0.69, and the load value on the operating profit growth rate x6 is 0.99. Therefore, it can be considered that the factor F_2 represents the development capability of the enterprise and is an indicator reflecting the sustainable development of the enterprise. The factor F_3 has a load value of 0.98 on the quick ratio x3 and a load value of 0.63 on the asset-liability ratio x4. Therefore, the factor F_3 can be considered as the solvency of the enterprise and is an indicator reflecting the capital flow of the enterprise.

Table 6. Orthogonal rotation factor load matrix

Index Name	Factor 1	Factor 2	Factor 3
Main business profit margin	0.83	0.49	0.15
sales gross profit margin	0.88	-0.08	0.01
quick ratio	0.17	0.11	0.98
asset-liability ratio	-0.60	-0.14	0.63
main business income growth rate	0.51	0.69	-0.34
operating profit growth rate	-0.04	0.99	0.15

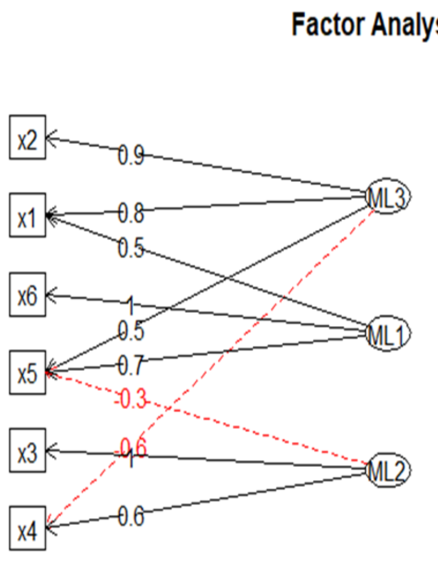


Fig 2. Factor analysis load matrix

The factor contribution through orthogonal rotation is shown in Table 7. The variance contribution rate of the factor F_1 representing profitability is 35%, the variance contribution rate of the factor F_2 representing the development capability is 29%, and the variance contribution rate of the factor F_3 representing the solvency is 25%. These three factors contain a total of 89% of data information.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

Table 7. Factor variance and its contribution (orthogonal rotation rotation)

Factor	variance	Contribution rate	Cumulative contribution rate
Factor1	2.12	0.35	0.35
Factor2	1.73	0.29	0.64
Factor3	1.52	0.25	0.89

4.3.4 Calculated factor variable score

Through the factor loading table and the factor contribution table after orthogonal rotation, the factor scores of the 12 listed companies in the automotive industry under study, which are also called comprehensive scores, can be calculated. It is calculated in such a way that the weight of each factor is the variance contribution rate, and the factor score is calculated from the linear function of each factor. The specific calculation formula is as follows:

$F = (0.35F1+0.29F2+0.25F3)/0.89$

Through the R statistical software, the comprehensive business performance scores of each sample are calculated by the regression method, and the weight of each factor's variance contribution rate as the total variance contribution rate is weighted and summed, and the comprehensive synthesis of 12 listed companies in the automobile industry is obtained. Score and ranking. As shown in Table 8.

Table 8. Factor analysis comprehensive score and its ranking

Company Name	Factor score			Comprehensive score	rank
	F1	F2	F3		
Yutong Bus	1.34478	0.212829	1.040374	0.893934	01
Great Wall Motor	1.51947	0.376287	0.352954	0.821142	02
Changan Automobile	1.02173	0.278728	0.429658	0.614839	03
SAIC	0.20383	0.268966	0.438295	0.291140	04
BYD	0.29196	0.645303	-0.989238	0.043405	05
China National Heavy Duty Truck	-0.49413	0.383842	0.311641	0.016698	06
Dongfeng Motor	-0.57468	0.095913	0.584698	-0.030648	07
Huatai Shares	-0.61714	0.907570	-1.277745	-0.312706	08
Jinlong Automobile	-1.62370	-0.523554	1.644706	-0.344684	09
Jianghuai Automobile	-1.16628	0.107348	-0.033155	-0.435364	10
Hippocampus	-0.32132	0.225513	-1.729963	-0.543575	11
FAW Car	0.41547	-2.978745	-0.772226	-1.014182	12

As can be seen from the above table, the number one is Yutong Bus, the second is Great Wall Motor, Changan Automobile and SAIC Group are close behind. Yutong Bus has won the championship of China's large and medium-sized passenger cars for 14 consecutive years, and its sales volume has remained the highest in the world. Since 2004, Yutong has sold about 45,000 large and medium-sized buses in overseas markets, accounting for more than 1/3 of China's total passenger car exports. It has ranked first in the industry for many years. Great Wall Motor is the first private car company in China listed in Hong Kong H-shares, the largest pickup truck manufacturer in China, and a multinational company. Changan Automobile is a well-known automobile manufacturing enterprise in China and a leader in Chinese brand automobiles. It is a car enterprise with a total production and sales volume of 10 million vehicles in China. It has achieved the top sales of Chinese brand cars for 10 consecutive years. SAIC is the largest listed company in the domestic A-share market. Some of the scores in the above table have negative numbers, indicating that the firm's performance in the corresponding measure of the corresponding factor or total factor is lower than the average of the 12 auto companies in the corresponding indicators. From the calculation of the comprehensive score F, it can be

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

known that the weights of the factors F1, F2 and F3 are successively smaller, so half of the auto companies' higher scores on the first two factors will lead to an increase in the final ranking, while another Half of the car companies' lower scores on the first two factors will result in a slightly lower final ranking.

4.4. Comprehensive Evaluation

In order to more intuitively analyze the performance of 12 listed companies in the automotive industry, RStudio statistical software is used to paint radar charts, also known as astrological charts. Prior to this, it is necessary to normalize the load value and factor score of each factor on the variable. The specific transformation formula is as follows:

$$z_{ij} = \frac{x_{ij}-x_{jmin}}{x_{jmax}-x_{jmin}} \text{ , i=1, 2, ..., n, j=1, 2, ..., m}$$

Where x_{ij} is the observed value, x_{jmin} is the minimum observed value of the jth indicator, and x_{jmax} is the maximum observed value of the jth indicator. After the normalization transformation, the unit of measurement of each indicator observation value is eliminated, and the normalized transformation observation value z_{ij} is between 0 and 1.

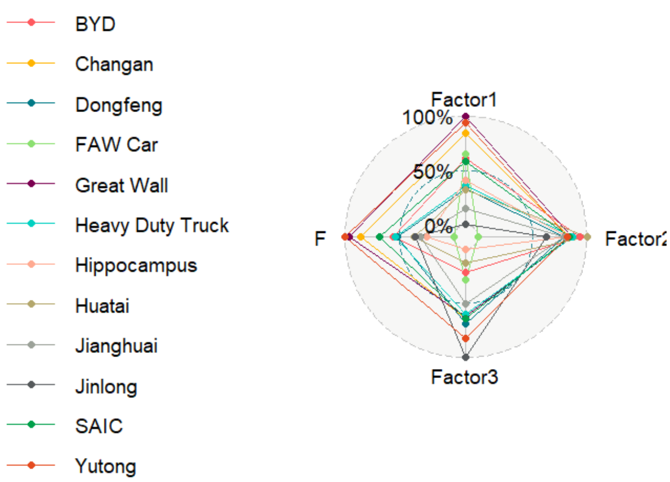


Fig 3. Radar chart

In the above radar chart, F represents the comprehensive score of each car company, F_1, F_2 and F_3 represent the common factor scores of each sample, the scores become higher from the inside to the outside, and the lines with different colors represent different enterprises. The radar chart shows very intuitively that Yutong Bus has the highest comprehensive score F, followed by Great Wall Motor and Changan Automobile.

It can be known from the calculation method of the comprehensive score F that the weights of the factors F_1, F_2 and F_3 are successively smaller, so half of the automobile companies score higher on the first two factors, which leads to an increase in the calculated comprehensive score F. The other half of the car company's lower score on the first two factors will result in a slightly lower calculated composite score F.

It is very intuitive from the radar chart that the Yutong bus with the highest score in the comprehensive score F has a high score in the profitability factor F_1 and the development capability factor F_2; the lowest score in the comprehensive score F is the FAW car. The profitability factor F_1 and the development ability factor F_2 also have relatively low scores.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

The companies that scored the top in the comprehensive low score F tend to score higher on the first two common factors, and vice versa.

It can be seen from the factor score table 8 that the three companies with the highest scores on the profitability factor F_1 are Great Wall Motor, Yutong Bus and Changan Automobile. The comprehensive scores of these three companies are also much higher than other companies, indicating that this The three companies are far superior to other companies in terms of profitability, while the three companies of Jinlong Automobile, Jianghuai Automobile and Huatai are relatively weak. The three companies with the highest scores on the development capability factor F_2 are Huatai, BYD and Haima, and most of the remaining companies have a small gap in the development capability factor F_2, indicating that among the listed companies in the automotive industry, Most companies pay more attention to long-term development capabilities. FAW Car has the lowest score on the development capability factor F_2, indicating that it has the worst development capability among the selected 12 listed auto industry companies, and FAW Car has a low score on the profitability factor F_1. It also has the lowest overall score F, so it should be improved from within the company to focus on improving its capabilities. The three companies with the highest scores on the solvency factor F_3 are Jinlong Motor, Yutong Bus and Dongfeng Motor, indicating that these three companies have strong solvency in the automotive industry, while Haima Automobile, Huatai, BYD and FAW Cars The solvency factor F_3 has the lowest score, indicating that the four companies have the weakest solvency and the risk.

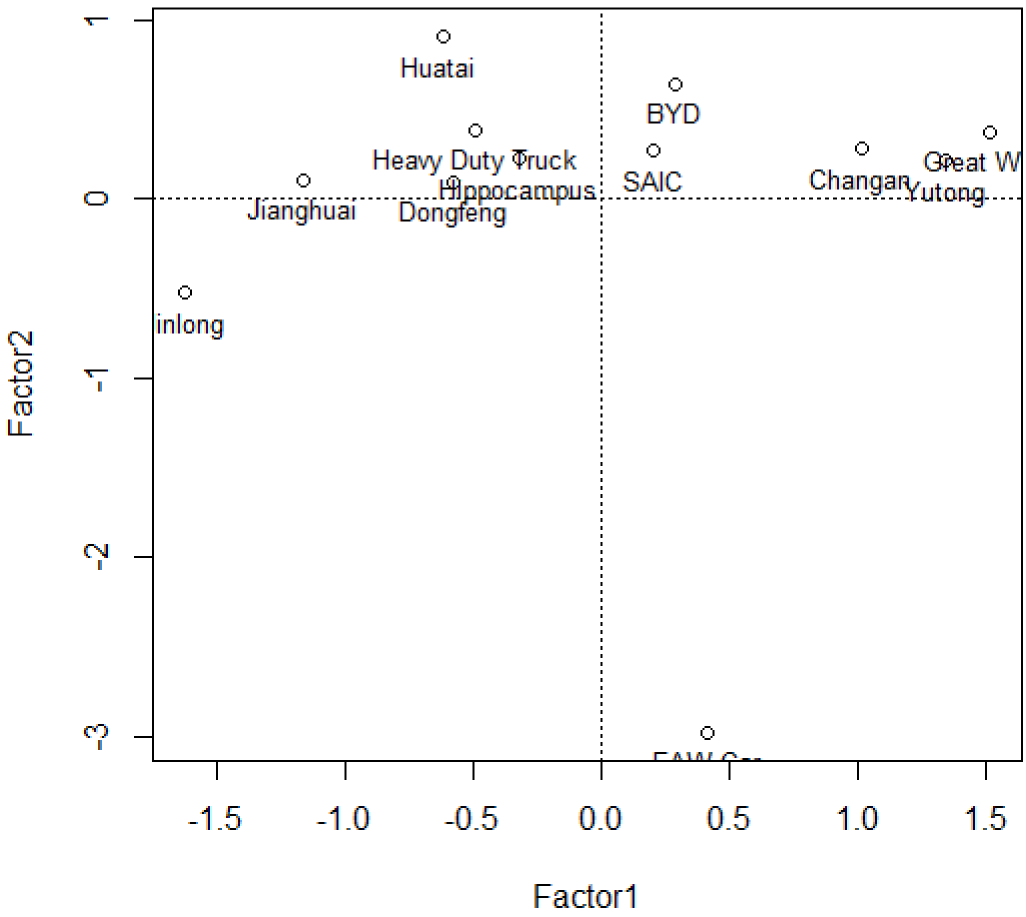


Fig 4. Factor score map

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

In the factor score map Fig. 4, the three companies with the highest comprehensive scores, Yutong Bus, Great Wall Motor and Changan Automobile, are located in the first quadrant. From the previous analysis, the three companies are on the profitability factor F_1 and the development capability factor F_2. The scores are relatively high, especially on the factor F_1. The FAW sedan with the lowest comprehensive score is located at the lower left of the fourth quadrant of the factor score map, and the hippocampus is located at the lower right of the second quadrant. This and their respective scores on the profitability factor F_1 are not high and the development ability factor F_2 and solvency The scores on the factor F_3 are relatively backward, so they are also consistent with the ranking of the comprehensive score. The remaining auto companies in the middle of the factor F_1 and factor F_2 scores, such as the above-mentioned automobile group, Dongfeng Motor, etc. appear on the factor F_1 axis or the factor F_2 axis not far from the far point.

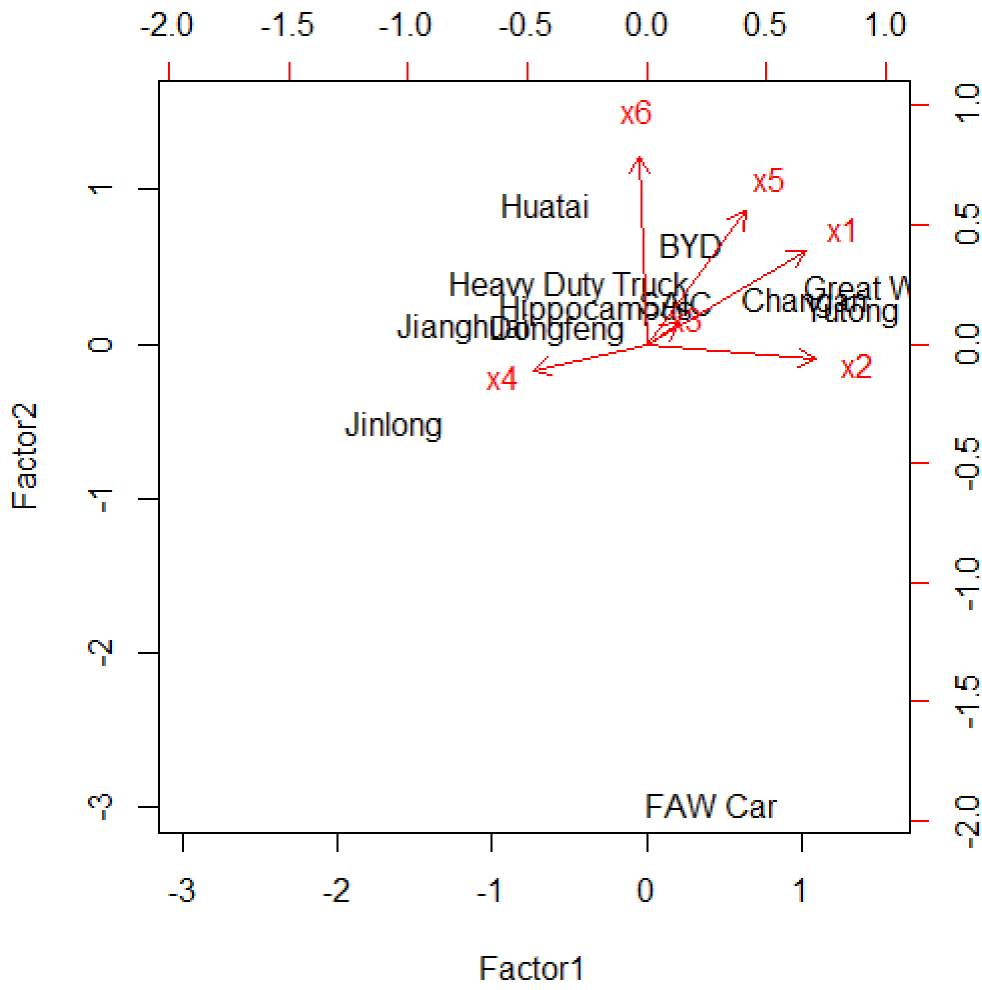


Fig 5. Factor information overlay

Through the R statistical software "biplot" function, the scatter plot of the original data about the common factors F_1 and F_2 and the information overlap of the original coordinates in the direction of the factor are obtained. This map can fully reflect the common factor between F_1 and F_2 and the original data. Contact. As can be seen in Fig. 5, different observations have different response strengths in different automotive companies. Most of the observations have high reaction intensity in Great Wall Motor, Yutong Bus, Changan Automobile and SAIC, indicating that most of the above-mentioned companies have higher observation indicators. Jinlong Automobile has a higher index of asset-liability ratio. Huatai has a higher growth rate of

ISSN: 2472-3703
DOI: 10.6911/WSRJ.201909_5(9).0009

its operating profit, while FAW Car is significantly lower than other companies in terms of its operating profit growth rate.

In general, the top auto companies with comprehensive scores are diversified and can lead other companies in many ways.

On the whole, the gap between the 12 listed companies in the automotive industry is quite clear, and according to the above analysis, there are very few companies that can score high on three factors, namely, profitability and development ability. Companies that are strong in terms of solvency. Therefore, the automobile industry should focus on improving the relatively weaker operating capacity and coordinate the development of three capabilities: profitability, development capability and solvency, with a view to improving the overall level of the enterprise.

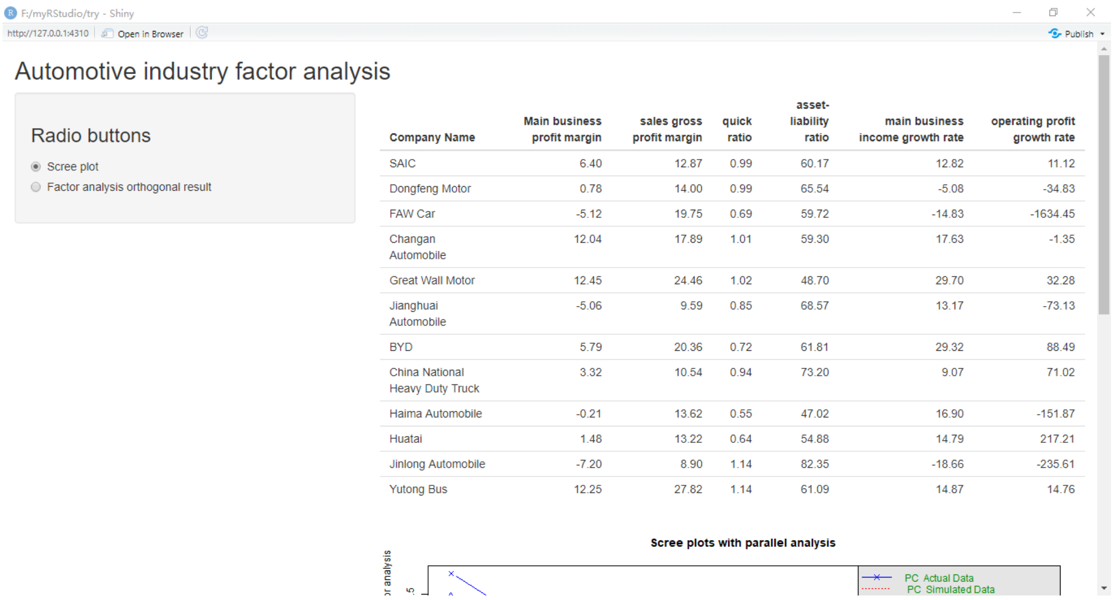
5. SHINY DISPLAY

5.1. Introduction to Shiny

Shiny is an open source R package that provides a web framework for building web applications using R; transforming data analytics into interactive web applications without front-end knowledge. Shiny only needs a few lines of code to build a useful web application, and its application will automatically refresh the calculation results, that is, when the user modifies the input, the output value will be automatically updated without having to manually refresh it in the browser. Shiny can run in any R environment, with a reactive programming model, its highly customized slider widget has built-in support for animation, and Shiny comes pre-built with output widgets that can be used to display graphics, tables and printouts. R object.

5.2. Chart Using the Shiny Display Factor Analysis Process

Through RStudio statistical software, Shiny completed a simple data visualization work and showed some of the previous charts for the factor analysis process of 12 listed companies in the automotive industry. The specific interface is as shown:



Company Name	Main business profit margin	sales gross profit margin	quick ratio	asset-liability ratio	main business income growth rate	operating profit growth rate
SAIC	6.40	12.87	0.99	60.17	12.82	11.12
Dongfeng Motor	0.78	14.00	0.99	65.54	-5.08	-34.83
FAW Car	-5.12	19.75	0.69	59.72	-14.83	-1634.45
Changan Automobile	12.04	17.89	1.01	59.30	17.63	-1.35
Great Wall Motor	12.45	24.46	1.02	48.70	29.70	32.28
Jianghuai Automobile	-5.06	9.59	0.85	68.57	13.17	-73.13
BYD	5.79	20.36	0.72	61.81	29.32	88.49
China National Heavy Duty Truck	3.32	10.54	0.94	73.20	9.07	71.02
Haima Automobile	-0.21	13.62	0.55	47.02	16.90	-151.87
Huatai	1.48	13.22	0.64	54.88	14.79	217.21
Jinlong Automobile	-7.20	8.90	1.14	82.35	-18.66	-235.61
Yutong Bus	12.25	27.82	1.14	61.09	14.87	14.76

Fig 6. Shiny interface 1

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

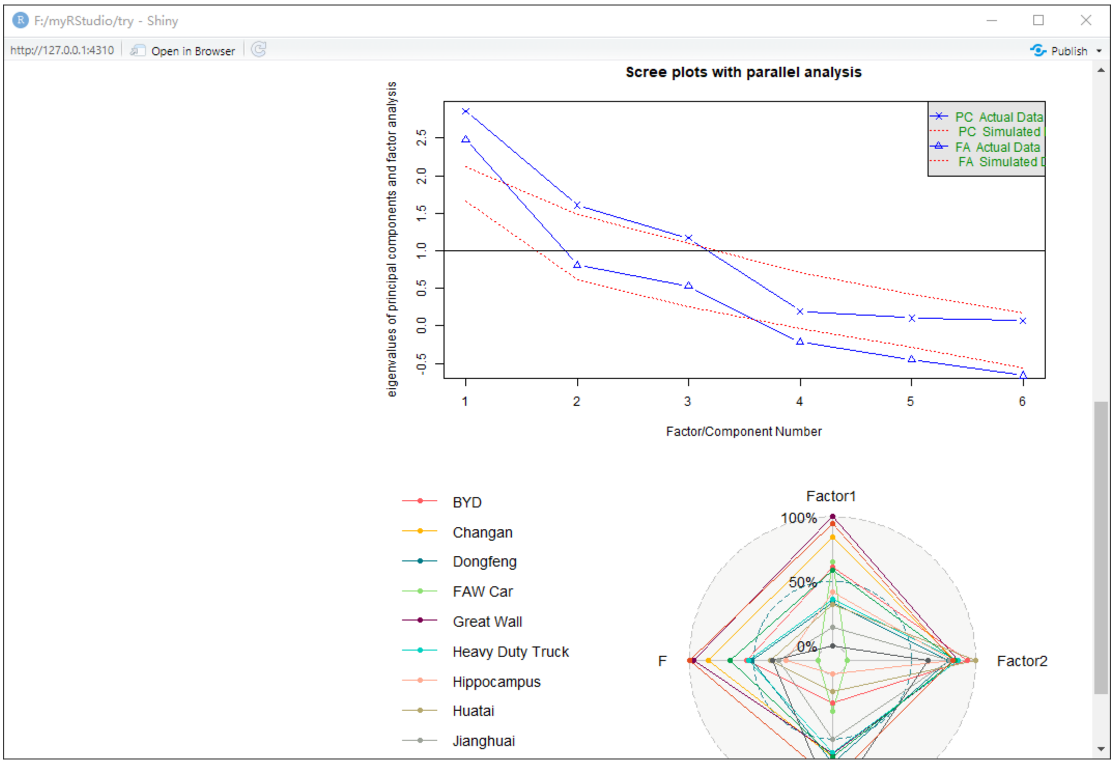


Fig 7. Shiny interface 2

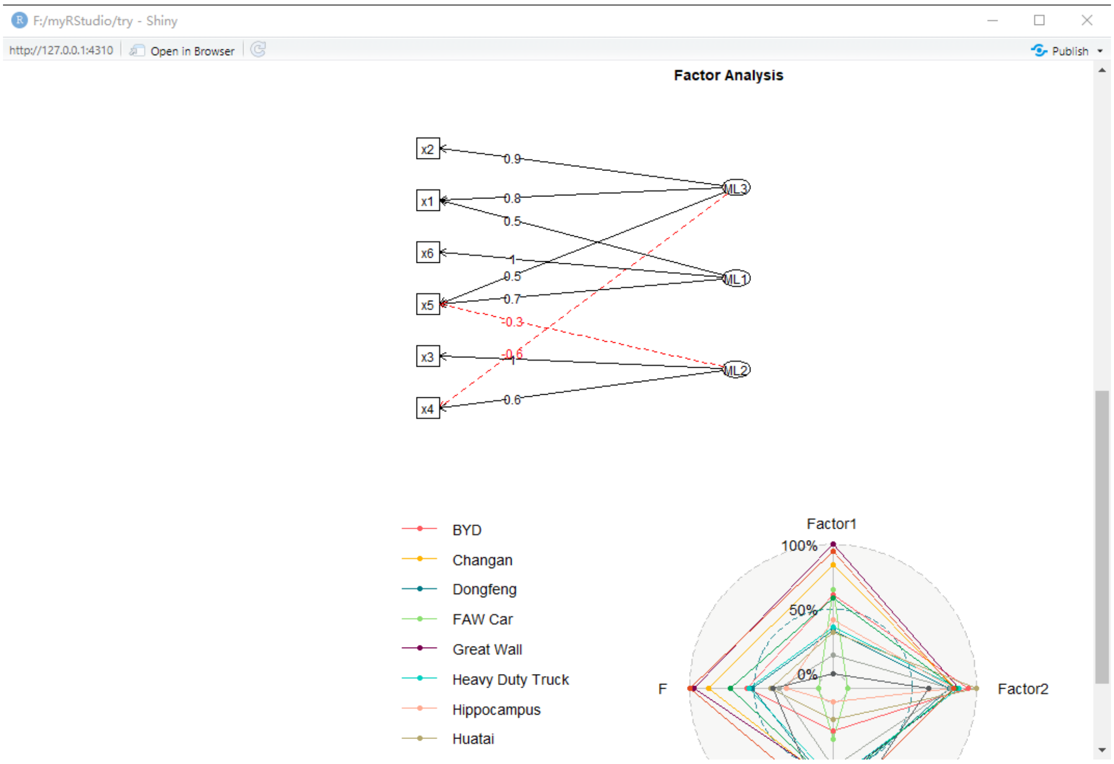


Fig 8. Shiny interface 3

The main panel shows the contents of three areas, the first area is the raw data of 12 listed companies in the automotive industry; the second area can be orthogonalized by the selection button of the sidebar in the "Gravel Map" and "Factor Analysis" The result is "switched"; the

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

third block shows the radar chart, which contains factor scores and comprehensive score information. See the appendix for the specific running code.

6. CONCLUSION AND SUGGESTION

Based on the factor analysis of the relevant financial indicators of 12 listed companies in the automotive industry, this paper extracts three common factors for comprehensive evaluation in automobile companies: profitability factor, development capability factor and solvency factor.

After factor analysis, it is found that the top auto companies with comprehensive scores are diversified and can lead other companies in many aspects. Through the comprehensive score ranking, it is known that Yutong Bus, Great Wall Motor and Changan Automobile are among the top three. These auto companies have diversified advantages and can lead other companies in many aspects. The Jianghuai Automobile, Haima Motor and FAW Car are ranked relatively backward.

The gap between listed companies in the automotive industry is quite clear, and according to the analysis, there are very few companies that can score high on three factors, that is, they are strong in terms of profitability, development ability and solvency. There are very few companies. Therefore, the automobile industry should focus on improving the relatively weaker operating capacity and coordinate the development of three capabilities: profitability, development capability and solvency, with a view to improving the overall level of the enterprise.

REFERENCES

[1] Wang Binhui. "Multivariate Statistical Analysis and R Language Modeling" [M]. Jinan University Press, 2010.

[2] Wang Binhui. "Data Statistical Analysis and R Language Programming" [M]. Peking University Press, 2014.

[3] ZHANG Yufang. "Performance Evaluation of Domestic Listed Vehicle Enterprises Based on Factor Analysis"[J]. Economic Research Guide, 2010(1): 73-74.

[4] Wang Wei. "Application of Factor Analysis Method in Financial Performance Evaluation of Haier Group Corporation"[J]. Journal of Shandong Agricultural University, 2013, 44(1): 111-116.

[5] PAN Xia, YAN Xiaofeng, CHEN Jun. "Research on Competitiveness Evaluation of High-tech Industry in 29 Regions of China Based on Factor Analysis"[J]. Economic Issues Research, 2013(4).

[6] Wang Xia, Wang Yanhong, Su Lin, et al. "Construction and Evaluation of the Fusion Index System of National High-tech Zones Based on Factor Analysis and Entropy Method"[J]. Science and Technology Management, 2014(7): 79- 88.

[7] Li Zhongwei, Wang Lijie, Zhou Dapeng. "Performance Evaluation of Coal Listed Companies Based on Factor Analysis Method"[J]. China Mining Industry, 2008(2):10-13.

[8] Zhou Hong, Wang Haimei, Zhang Wei. "Research on Performance Form of Relative Performance Evaluation"[J]. Accounting Research, 2008(6): 72-76.

APPENDIX

```
options(digits=5)
install.packages("readxl")
library("readxl")
car<-read_excel("F:/myRStudio/car.xlsx");car
install.packages("GPArotation")
```

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

```
library(GPArotation)
install.packages("psych")
library(psych)
cor<-cor(car);cor
KMO(car)
cortest.bartlett(cor(car))

fa.parallel(car,n.obs=12,fa="both",n.iter=100,main="Scree plots with parallel analysis")
fa<-fa(car,nfactors=3,n.obs=12,rotate="none",fm="ml");fa

fa.varimax<-fa(car,nfactors=3,rotate="varimax",fm="ml");fa.varimax
fa.diagram(fa.varimax,simple=FALSE)

library(mvstats)
X=read.table("clipboard",header=T);X
row.names(X)<-
c("SAIC","Dongfeng","FAW Car","Changan","Great Wall ","Jianghuai","BYD","Heavy Duty Truck","
Hippocampus","Huatai ","Jinlong","Yutong")
Fa1=factanal(X,3,scores = 'regression')
factanal.rank(Fa1,plot=T)

install.packages("ggplot2")
install.packages("knitr")
library("ggplot2")
library(knitr)
devtools::install_github("ricardo-bion/ggradar", dependencies=TRUE)
library("ggradar")
car1<-read_excel("F:/myRStudio/car1.xlsx");car1
ggradar(car1,group.point.size = 2,group.line.width = 0.5)
biplot(Fa1$scores,Fa1$loadings)

##ui

library(shiny)

shinyUI(fluidPage(

  # Application title
  titlePanel("Automotive industry factor analysis"),

  sidebarLayout(
    sidebarPanel(
```

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

```
        radioButtons("radio", label = h3("Radio buttons"),choices = list("Scree plot" = 1,"Fact
or analysis orthogonal result" = 2))
      ),
      mainPanel(
        tableOutput("cardata"),
        plotOutput("distPlot"),
        plotOutput("radar")
      )
    )
  ))


  ##server

  library(shiny)
  install.packages('GPArotation')
  shinyServer(function(input, output) {

    output$distPlot <- renderPlot({
      options(digits=5)
      library(GPArotation)
      library(psych)
      library("readxl")
      car<-read_excel("F:/myRStudio/car.xlsx")
      fa.varimax<-fa(car,nfactors=3,rotate="varimax",fm="ml")
      if(input$radio==1){fa.parallel(car,n.obs=12,fa="both",n.iter=100,main="Scree plots wit
h parallel analysis")}
      if(input$radio==2){fa.diagram(fa.varimax,simple=FALSE)}

    })
    output$cardata <- renderTable({
      options(digits=5)
      library("readxl")
      cardata<-read_excel("F:/myRStudio/cardata.xlsx")

    })
    output$radar <- renderPlot({
      library("ggplot2")
      library(knitr)
      devtools::install_github("ricardo-bion/ggradar", dependencies=TRUE)
      library("ggradar")
      car1<-read_excel("F:/myRStudio/car1.xlsx")
```

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201909_5(9).0009

```
    ggradar(car1,group.point.size = 2,group.line.width = 0.5)
  })


})
```