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Principal component analysis-based Chinese native sports brand development path research

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ABSTRACT

With people's living standard improvement, sports consumption has gradually occupied one part of people's total consumption. Each sports brand has appeared intense competitions. In a globalizing world, Chinese native brands have accepted numerous challenges. Domestic market competition is fierce, which international market expanding is difficult. During the double pressures, enhance brand sales have become the problem in sports product manufacturing. In order to provide better development direction, the paper takes domestic six kinds of native brands as research objects, utilizes principal component analysis method to analyze twelve indicators, and defines three comprehensive indicators. The conclusion provides certain guiding significances to each brand manufacturing company's development.

KEYWORDS

Sports brand; Development path; Principal component analysis; Comprehensive indicator; Influence factors.

INTRODUCTION

In 2001, China joined in WTO; it was both opportunity and challenge for China. Thereupon, Chinese product could go into the world, and meanwhile Chinese markets would also suffered international impacts. After 13 years, now Chinese markets are full of vigor, the flourishing scenes come into people's eyes. Chinese products go abroad and into the world, however Chinese sports product hasn't well developed in international market. Chinese native brands' sports products and international brands generate intense competition at home. Presently, Chinese market sports products high-end brands have no native brands. Very few native brands can occupy first-tier cities' markets, and become mid-range sports brands. Most of domestic sports products only can be used as low end sports products, which occupies second-tier and third-tier cities' markets. From the perspective of Olympic Games sponsors, Chinese native brands even suffered a setback. As earlier as 2008 before, native brand that appeared in Olympic Games field only had Li-Ning. Of course, Chinese sports brands have also good development trend. Such as, in 2012 Anta has become Chinese team receiving awards sponsor.

As earlier as September, 2000, Zhan Jian-Guo and others in brief viewing sports market management brand marketing "discussed brand marketing's important effects on sports market management operation". In Oct. 24th, 2000, market newspaper published subject as "National features brilliant brands"[22], it stated Li-Ning awards receiving outfits. In 2001, market newspaper published the article of how to build top sports brands, the article pointed out "Good times rely on accidental or historical causes to suddenly leap into fame have already passed. Nowadays, only by a series of strategies implementation then may be succeeding".

Chinese sports development started late, sports product development even fell behind developed countries. It kept certain paces with developed countries in the technical problems, Chinese sports brand development was up to consumers' degrees of recognition, consumption awareness, and consumption habits. In recent years, people have gradually promoted sports consumption awareness, which is a good opportunity for sports brands development. People consumption status on each kind of sports brands are important influence factors whether sports brand enterprise can be survival or not. Therefore, look for factors that affect sports brand consumption has become main path to research sports brands. In order to easier to Chinese sports brand better development, the paper takes university students' sports brand consumption status as research objects, analyzes sports brand consumption status influence factors.

MODEL ESTABLISHMENT

Chinese sports manufacturing industry doesn't dominant no matter in international market or domestic market. The model takes Chinese six native brands as examples, makes comparison of them on twelve indicators so that gets their influential comprehensive indicators.

Data processing

TABLE 1 : Main native sports brands sales status influence factor 1

Brand	*Total amount of retail stores*	*Number of direct-sale stores*	*Storage increment in 2011*	*Storage increment in 2012*	*Difference1*
Li-Ning	3000.00	800.00	11.33	11.39	0.05
Anta	6000.00	1500.00	6.18	6.28	0.10
361 degree	5000.00	200.00	4.51	3.66	-0.85
Peak	3000.00	100.00	4.21	5.29	1.08
X-step	6000.00	200.00	6.72	7.01	0.29
China Dongxiang	0.00	0.00	0.00	0.00	0.00

TABLE 2 : Main native sports brands sales status influence factor2

Brand	*Retail outlet (1) 2011*	*Retail outlet (2) 2012*	*Difference (3)2*	*Turnover (4)*	*Difference (5)3*	*Net profits (6)*	*Difference (7)4*
Li-Ning	8255.00	7303.00	-952.00	38.80	-9.50	0.44	-85.0
Anta	7835.00	7808.00	-27.00	39.34	-11.6	7.70	-17.0
361 degree	7865.00	8050.00	185.00	28.69	-9.90	5.96	-22.9
Peak	7806.00	7059.00	-747.00	16.10	-28.5	2.40	-43.3
X-step	7596.00	7603.00	7.00	26.00	1.40	4.68	0.30
China Dongxiang	3119.00	2550.00	-569.00	8.32	-29.4	0.94	-56.9

Principal component analysis

Main thought of principal component analysis is variable's dimension reduction. It is a statistical analysis method that transforms multiple variables into fewer main variables. It generally is used to data compression, system evaluation, regression analysis and weighted analysis so on.

May way of principal component analysis is reducing dimension of variables, which is recombining original many variables with correlation into a group of uncorrelated variables to replace original variables. Therefore, we can pay attention to every time observation's variables that have maximum variation, to every time observation's small changed variables that can be used as constant to process and get rid of them, so that it reduces variables number in problem that needs to be considered.

Assume that there is m pieces of original indicators to do principal component analysis, which are recorded as $x_1, x_2, \cdots, x_m$, now it has n pieces of samples, corresponding observation value is $x_{ik}(i = 1,2,\cdots,n)$, and $k = 1,2,\cdots,m$ takes standardization transformation, and then transform x_k into x_k^*, that:

$$\mathbf{x_k^* = \frac{x_k - \overline{x_k}}{s_k},\ k = 1,2,\cdots,m} \qquad \textbf{(1)}$$

Among them, $\overline{x_k}$ and s_k are respectively x_k average number and standard deviation, x_k^* average number is 0, standard deviation is 1.

According to each sample original indicator observation value x_{ik} or after standardization observation value x_{ik}^*, it solves coefficient b_{kj}, establish indicator x_k^* that is transformed through standardization to express comprehensive indicator z_j equation $z_j = \sum_k b_{kj} x_k^*$, which can also establish equation that uses original indicator x_k to express comprehensive indicator z_j:

$$\mathbf{z_j = \sum_k \tilde{b}_{kj} x_k^* + a_j} \qquad \textbf{(2)}$$

There are two requirements on defining b_{kj}:

(1) Comprehensive indicators are mutual independent from each other or uncorrelated.

(2) Every comprehensive indicator reflected each sample gross information content is equal to corresponding feature vector (comprehensive indicator coefficient) feature values. In general, it is required that selected comprehensive indicator feature vales contribution ratios sum to be above 80%.

Principal component analysis general steps:

(1) According to observed data, calculate $\overline{x_k}$ and $s_k(k, j = 1,2,\cdots,m)$。

(2) By correlation coefficient matrix R, it can get feature value $\lambda_j \left(j=1,2,\cdots,m\right)$ and each principal component variance contribution、contribution ratio and accumulative contribution ratio, and define principal component reserved number p with accumulative contribution ratio as evidence.

(3) m pieces of basic equations are as following:

$$\begin{cases} r_{11}x_1^{(j)} + r_{12}x_2^{(j)} + \cdots + r_{1m}x_m^{(j)} = \lambda_j x_1^{(j)} \\ r_{21}x_1^{(j)} + r_{22}x_2^{(j)} + \cdots + r_{2m}x_m^{(j)} = \lambda_j x_2^{(j)} \\ \cdots \\ r_{m1}x_1^{(j)} + r_{m2}x_2^{(j)} + \cdots + r_{mm}x_m^{(j)} = \lambda_j x_m^{(j)} \end{cases} \quad (3)$$

Among them, $j=1,2,\cdots,m$.

Proceed with Schmidt orthogonalization, for every λ_i, solve its basic equations solution $x_1^{(j)}$, $x_2^{(j)}$, …, $x_m^{(j)}$ $\left(j=1,2,\cdots,m\right)$, and then let:

$$b_{kj} = \frac{x_k^{(j)}}{\sqrt{\sum_k \left(x_k^{(j)}\right)^2}} \quad (4)$$

It can get expressed by x_1^*, x_2^*, …, x_m^* principal component $z_j = \sum_k b_{kj} x_k^*$, or input $x_k^* = \frac{x_k - \overline{x_k}}{s_k}$ and then get expressed by x_1, x_2, …, x_m principal component $z_j = \sum_k \tilde{b}_{kj} x_k^* + a_j$.

(4) Input x_1, x_2, …, x_m observed values into principal component expressions, calculate each component value.

(5) Calculate original indicator and principal component correlation coefficient that is also factor loading that use it to explain principal component significances.

Analyze SPSS computed results

TABLE 3 : Common factor variance

	Initial	Extract
Total amount of retail stores	1.000	.998
Number of direct-sale stores	1.000	.509
Storage increment in 2011	1.000	.970
Storage increment in 2012	1.000	.974
Difference 1	1.000	.895
Retail outlet in 2011	1.000	.896
Retail outlet in 2012	1.000	.907
Difference 2	1.000	.995
Turnover	1.000	.970
Percentage change 1	1.000	.729
Net profits	1.000	.899
Percentage change 2	1.000	.965

Extract method: principal component analysis.

TABLE 3 represents every variable common degree result. TABLE 3's left side represents every variable explainable variance from all factors, while the right side represents variable common degrees. From table data, we can see that variable common degrees are very high, which shows most information in variables can be extracted by factors; it shows the analysis is valid.

TABLE 4 : Component matrix

	Component		
	1	2	3
Total amount of retail stores	.935	.296	.190
Retail outlet in 2012	.921	-.070	.235
Turnover	.888	-.294	-.309
Retail outlet in 2011	.862	-.280	.274
Percentage change 1	.836	.081	-.155
Storage increment in 2011	.725	-.662	-.079
Net profits	.674	.665	.038
Number of direct-sale stores	.628	-.213	-.263
Difference 2	.493	.861	-.100
Percentage change 2	.455	.797	.351
2012 Storage increment in 2012	.678	-.715	.059
Difference 1	-.214	-.391	.835

From TABLE 4, it is clear that non-rotated factor loading. From the table, it can get two main factors' loading values that are extracted by utilizing principal component method. In order to easy explaining factor definition, it should make factor rotation.

TABLE 5 : Describe statistics

	Average value	Standard deviation	Analyze N
Total amount of retail stores	3833.3333	2316.60671	6
Number of direct-sale stores	466.6667	578.50382	6
2011 Storage increment in 2011	5.4918	3.70976	6
2012 Storage increment in 2012	5.6043	3.77140	6
Difference 1	.1125	.61707	6
Retail outlet in 2011	7079.3333	1951.90806	6
Retail outlet in 2012	6728.8333	2077.28548	6
Difference 2	-350.5000	466.04195	6
Turnover	26.2083	12.32367	6
Percentage change 1	-14.5833	12.04449	6
Net profits	3.6867	2.89835	6
Percentage change 2	-37.4667	30.75221	6

From TABLE 5, it can get conclusion that in the twelve indicators, six native brands' maximum difference indicator is total amount of retail stores, minimum difference indicator is difference 1 that is difference between 2012 storage increment and 2011 storage increment.

From Figure 1, it is clear that principal component analysis total extracts three principal components this time, the one gets closer to coordinate axis means its factor loading is big and explanatory ability is relative stronger.

Figure 2 is feature values' scree plot. In general, the figure shows big factor steep slope and surplus factor gentle tail has obvious interruption. Generally selected main factors are in the very steeply slope, and factors lie in gentle slope have insignificant effects on total. From Figure 2, it is clear that the former two factors are in the relative steeply slope, and starts from the third factor, the slope turns to be gentle, while starts from the sixth factor, the slope is nearly zero, therefore select three factors as comprehensive factors.

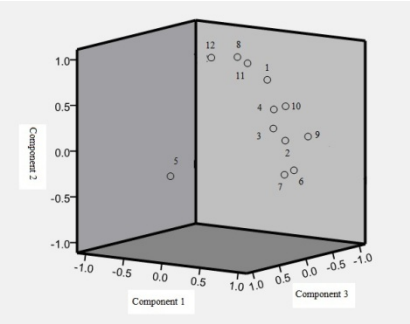

Figure 1 : The view of the rotating components of the space

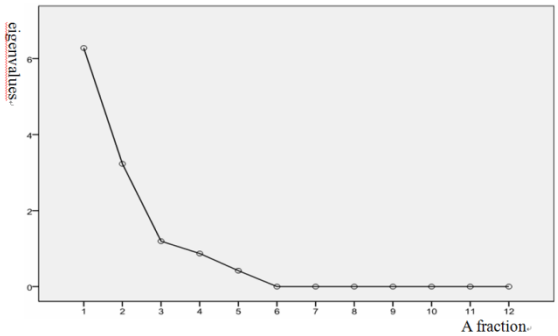

Figure 2 : Scree plot

TABLE 6 : Principal component variables

z1	*z2*	*z3*
13904.26	478.7	555.19
17951.47	1704.5	1155.39
16128.24	1592.3	607.54
12860.16	570.5	393.88
16458.93	1804.08	872.21
3626.18	-242.52	-58.46

TABLE 6 provides three principal components variables that are calculated by factor analysis results. In table, ever y principal component variable is original variables linear combination after standardization, and every principal component variable and other principal components are uncorrelated. Linear combination equation is as following:

$$\begin{aligned} z_1 &= u_{11}X_1 + u_{12}X_2 + \cdots + u_{16}X_6 \\ z_2 &= u_{21}X_1 + u_{22}X_2 + \cdots + u_{26}X_6 \\ z_3 &= u_{31}X_1 + u_{32}X_2 + \cdots + u_{36}X_6 \end{aligned} \quad (5)$$

Figure 3 shows six native brands during 2011 to 2012, each native brand net profits status. By above Figure 3, it is clear that Anta net profits are the highest, however Li-Ning as most senior sports brand its net profits is the lowest. Li-Ning company high level leader changes frequently during this time, inventory increases, sales promotion increases, and these problems let it to get caught in hard situations. Thereupon, it is clear sports brand marketing strategies play crucial roles in sports brand performance.

Model evaluation

The method utilizes dimensionality reduction strategy that uses fewer variables to replace original multiple variables, these fewer variables concentrate on reflecting original data most

information. In addition, the model makes objective, scientific evaluation on sports brands consumption status by calculating comprehensive principal component function scores, it more focuses on information comprehensive evaluation. The method also has certain drawbacks, such as, when principal component factor loading positive and negative symbols are simultaneously existing, evaluation function significances will not be clear, naming clarity will be low, only involve a group of variables' correlations. The model analyzes six native brands, obtained three comprehensive indicators don't adapt to all brands, therefore, when researched brands change, comprehensive indicator will also change.

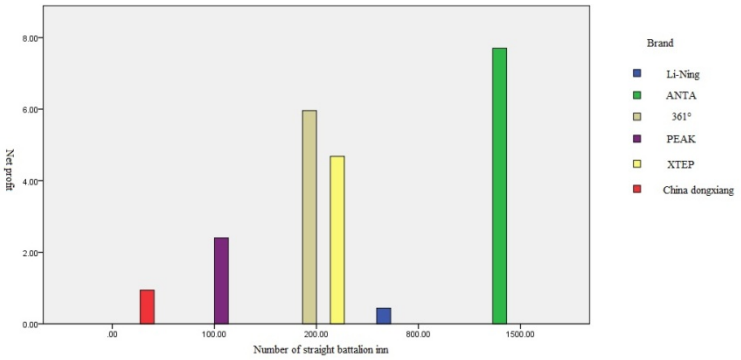

Figure 3 : The net profit of six brands

CONCLUSION

Principal component analysis is a mathematical tool that looking for main variables from several variables, it can help us to look for fewer main variables from multiple variables. The model application field is very widely, such as "regional water resources carrying capacity problem", "Town sports evaluation", "network comprehensive performance evaluation problem" and other aspects' analysis problems. The paper applies principal component analysis into sports brands field, it gets model accuracy is high, analyticity is strong. By the paper established model, it is clear that there are three sports brands influential comprehensive indicators. It is noteworthy that the model analysis is carrying on in case that six Chinese native brands are used as research objects. Therefore, in future these six native sports brands development process, adjust company development ways so as to arrive at more ideal company performance.

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