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A new approach factor- entropy with application to business costs of SMEs in Shanghai

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Abstract

Business cost is acknowledged as one of the priorities in SMEs research. In this study, the business cost of SMEs in Shanghai was primarily measured using Factor-Entropy analysis method. The purpose of this study is to effectively resolve the issue of simplification and assignment evaluation index system on business costs of SMEs in Shanghai. However, this study uses factor analysis to interpret the data on indicators, through a cross-sectional survey, considering the objective empowerment with entropy method. It was shown that factor-entropy method to evaluation index system has advantages. The samples selected involves 309 executives and managers of 16 SMEs in shanghai that are in support of the development funds of Shanghai SMEs in China in 2013. Finally, Factor-Entropy analysis method is a combination of subjective and objective evaluation method, which are the indicators of the main component indexes calculated entropy valves and sorting with scores. The results show that the impact of the external environment (Policies and market-oriented operation) in the Multi-target of Business-cost was significant and positive. The value obtained in this study is to provide an applicable unique measurement method to situations where the necessary information is insufficient for complex or fuzzy systems and relations, and mainly identify and evaluate information of business costs in small medium-sized businesses in Shanghai.

Keywords

Entropy, Evaluation of business costs, Factor analysis, Shanghai SMEs.

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Introduction

In recent times, the business costs in Shanghai, China, in the index system, has been high, especially when comes to labor, raw materials and environmental resources. Facing RMB appreciation and "re-industrialization" trend in developed countries, low-cost era has been away from small cities in China (Christina Nelson, 2011) let alone Shanghai. In particular, SMEs (Small to Medium-sized Enterprises) in Shanghai lie in the global industrial chain-end, which rely on cost drivers. It is imminent on how to reduce the cost of doing business for SMEs in Shanghai. Research on the cost of doing business for SME has been one of the most important research fields in macroeconomics and other aspects that have been studied.

For example, JIANG Yi-ren, Vice Mayor of Shanghai, during the opening meeting of the Third Speech Economist Roundtable on Shanghai on February 28 in 2002, said that Shanghai will strive to reduce the cost of doing business with investors (Jiang, 2002). Since then scholars have embark on a wave of study on business cost in Shanghai, For example, Ann (2004), Pan (2005), Guo (2006), Shi (2007), Chen (2010), Zhou and Sun (2011, 2012 and 2013) and many others researchers examined the cost of business in industrialized countries. While each of these studies greatly contributes to the research field, studies on the measurement of business cost of SEMs are very limited.

The recent PRC government policies will help increase the cost of doing business in China (Christina Nelson, 2011). SMEs are the lifeblood of modern economics (Ghobadian & Gallear, 1996). Undoubtedly, Shanghai SEMs constantly meet the challenges of changing the environmental factors in business, and SMEs have solitary features that differentiate them from marketing operation. Nonetheless, SMEs are often neglected in the context of business and society theory building (Raju *et al.*, 2011; Kumar *et al.*, 2012). The high business cost is the reason for the difficult survival of SMEs. In such a situation, the awareness of the nature of the business cost will help in the management of SMEs. In this research, we calculated and

evaluate the information on the cost of doing business for SMEs in Shanghai using the Factor-Entropy analysis method.

However, this study takes into account the specific business cost of the Shanghai SMEs goals that is more related to the field of policy-oriented, technological innovation, resources and the environment, and market operations (Zhou & Sun 2012). This research question based on how to evaluate a multi-target business cost of SMEs in Shanghai, which is hard to measure. Therefore, for few targets with less skill to overcome the drawbacks of subjective empowerment, the combine factor analysis and entropy methods, which have some science to a certain extent, were used (Zhou & Sun, 2013). In this study, it was discovered that the approach contributes positively in calculating the cost of doing business for SMEs and to evaluate the information. Also, the approach tries to identify the most important routes in improving the performance of SMEs' (Lee *et al.*, 2008). However, the information is not sufficient enough for the case to give an accurate quantitative evaluation value, and beside, evaluation research on how to make and evaluate multi-attribute is relatively small. To the best of our knowledge, few studies have been carried out on the existing approached, even with theoretical explorations of the measure of information and practical applications in various business and management backgrounds.

Based on the results of previous studies on how to measure and evaluate the cost of doing business for SMEs in Shangai, this study was aimed at constructing a comprehensive analysis method to solve the problem.

Literature review

Realistically, business venture should be short down if it cannot cover the costs required to be in business or the capital required for future growth and to stay in business (Carl, 2006). Therefore, the importance of business costs for enterprises is shown. In this article, we use the term "business cost" to represent the costs required to be and to Maintain and develop in business. In this study, the components of the business cost were extracted. Louis (1998) monitors all expenses,

including electricity, insurance, rent, equipment, etc., to determine the increases that may be expected. He also determine the value of maintenance contracts on a business equipment and the type of products that are more cost-effective to buy rather than lease. But how to properly evaluate the cost of doing business is the most important. Moreover, the kind of method to be used for evaluation should be considered, especially method that propose a quite complex matching model with capital accumulation, liquidity constraints and human capital, which prevent them from clearly evaluating the basic non-linearity's embedded in the matching approach (Jean-Olivier Hainault *et al.*, 2010). Moreover, all these additional features brings about very small business cycle costs. Therefore, in this study, the methods of the business cost in Shanghai were divided into three as explained further.

First, is the comparative analysis method. The business cost of Nanjing, Wuxi, Kunshan, Ningbo and Shanghai were compared (Ann, 2004), and a comparative study was carried out on the level of business cost structure of six eastern coastal provinces (Zhou *et al.*, 2012). Further, it has been shown that studies on comparative analysis were mainly on various regions within business costs; among the various components, each component can explain the differences between regions of specific indicators. However, these indicators of studies are too specific. Although, these studies have provided a good contrast of this phenomenon, the performance implications of this strategy to SMEs and regions in which development remain under-explored.

Second, is the comprehensive evaluation method in the application of subjective weighting of Evaluation method, such as the establishment of a system of three indicators in order to measure the cost of doing business, and the use of Delphi method (An *et al.*, 2004) and selection of AHP method (Shi *et al.*, 2007) in assessing the weighting factors (Chen, 2010). Empowering subjectivity is relatively strong, which would lead to a factor assessment that is too high or low. The true objectivity of the evaluation process is affected.

Third, there is a comprehensive evaluation method that is based on an objective evaluation of weighting method, such as the use of factor

analysis to determine the significant impact of various factors on the business costs of foreign direct investment (Pan *et al.*, 2005) and decomposition model of business costs (Guo, 2006). It is applied to the structural model and the DS evidence theory model used in corporate relocation decisions of case application analysis (Zhou & Sun, 2012). Based on a comprehensive weighting method and Empirical Research on entropy correction, the G1 method is used in regional business costs (Zhou & Sun, 2013). Although, the latter adopted an objective weighting method, this article has some instruction that are too small for index classification and as such, does not reflect a comprehensive information.

Few studies of capital components and social environments within the business cost of SMEs have been carried out, from both theoretical and empirical point of view (Zhou & Sun, 2013). However, in view of the inherent uncertainty and information involved in some practical situations, wit was found that the mentioned measures, indeed, encountered epistemic uncertainty, relevant to subjective information deficiency derived from the missing data or conflicting evidence. Based on the difficulty in measuring the multi-target of business-cost, this study chooses a comprehensive evaluation method and Factor-Entropy analysis method, which is a subjective evaluation method indicator of the main component indexes and objective calculated entropy valves, and sorting with scores. In this study, these methods are used in the evaluation of factor of business costs in order to determine their suitability for SMEs in Shanghai.

Methodology

Factor analysis

Factor analysis was first proposed by Charisa Spearman in 1904, an American psychologist, whose basic idea is to measure multiple indicators, using a linear combination of a few potential independent factor, which in the end, can reflect the main message of the original multiple measured indicators (Hao *et al.*, 2003).

Assuming the number of samples to be evaluated is n, and

Shanghai SME evaluation as p. The original variable index denote $X_1,X_2,\ldots,X_p$, their integrated indicators and targets for the new variables are $Z_1,Z_2,\ldots, Z_m$ ($m \leq p$):

$$\begin{cases} Z_1 = \iota_{11}X_1 + \iota_{12}X_2 + \cdots + \iota_{1p}X_p \\ Z_2 = \iota_{21}X_1 + \iota_{22}X_2 + \cdots + \iota_{2p}X_p \\ Z_m = \iota_{m1}X_1 + \iota_{m2}X_2 + \cdots + \iota_{mp}X_p \end{cases}$$

Simplified:

$Z = \left(\iota_{ij}X_p\right)_{n\times m}$ The coefficient ι_{ij} is determined by the following principles (QIU W. H., 2002):

1. Z_i and Z_j (i, j, ij=1,2,…,m) are independent of each other;
2. Z_1 is X_1, X_2... X_p the greatest in linear combination of all variances.

Z_2 and Z_1 are not related. Z_m and Z_1, Z_2, ..., $Z_{(m-1)}$ are not associated with X_1, X_2, ..., X_p. Z_m and are all linear combinations of the greatest variance. The new variable indexes Z_1, $Z_2,\ldots,Z_m$ ($m \leq p$) are referred to as the original variable indicators of $X_1,X_2,\ldots,X_p$, which are the main component. Z_1 is the proportion of the total variance of the largest, with $Z_2,\ldots,Z_m$ variance in descending order (GUOY, 2002)

Entropy method

Entropy is a thermodynamic concept. In 1948, CE Shannon introduced the concept of entropy in the information theory, which put forward the "information entropy" concept. It is a measure of system uncertainty, or the degree of ordering of the system; the greater the entropy, the greater the uncertainty of variables, and the greater the amount of information required. In a system that is more orderly, entropy is lower, while in a system that is more confuse, the entropy is higher. According to the basic principles of information theory, information is a measure of the degree of ordering of the system, while entropy is a measure of the degree of disorder of the system, both absolute values are equal, but opposite in sign. Entropy method is passed in accordance with the amount of information to decision makers for each indicator to determine the right size of the

corresponding index weight (QIU, 2002).

Assuming the number of samples to be evaluated at n indexes of Shanghai SME business cost is m, the index data matrix is denoted by $Z=(Z_{ij})$ $n\times m$ for some index Z_j, information entropy. In the entropy index of information entropy, a smaller index value indicates the degree of variation, which consequently result to greater amount of information provided, greater share of the weight and greater comprehensive evaluation of the role of entropy. Conversely, the greater the entropy, the smaller the index value indicates the degree of variation, the smaller the amount of information provided, and the less weight in the evaluation of the role of entropy (Gao *et al.*, 2005).

Ideas and steps of factor - entropy analysis

Factor- entropy analysis method is not a simple combination of these two methods. The traditional methods only consider a single factor: the evaluation indexes of business cost that are not solely. The factor-entropy method function by measuring the index information size in order to evaluate simultaneously the accuracy and size of index information. It helps to solve the multiple factors evaluation problem when applied in any field. The domain of entropy is only limited in the positive number, which limits its application. In this article, entropy analysis method can deal with the negative number (Qiu W. H., 2002). In this study the following set specific steps were considered:

1. Raw data normalized.

Select n numbers of Shanghai SMEs, the initial business cost index number is p, the matrix $X=(X_{ij})$ $n\times m$ $\lambda_1\geq\lambda_2\geq\ldots\geq\lambda_p$, where X_{ij} denotes the item j business cost index data i of Shanghai SMEs.

2. Standardized matrix calculated correlation matrix.

Initial financial indicators standardized, eliminating indicators incommensurability, and reveals a new data matrix as follows: $Y=(Y_{ij})n\times p$, Among

$$y_{ij}=\frac{X_{ij}-X_j}{\sqrt{var(X_j)}} \qquad (i, j=1,2,\ldots,p) .$$

3. Calculated eigenvalues, eigenvectors.

We can calculate the correlation coefficient matrix R, R_{ij}(ij=1,2,…,p) of the original variables. Y_i and Y_j correlation coefficient is calculated as:

$$R_{ij}=\frac{\sum_{k=1}^{n}(Y_{ki}-Y_i)(Y_{kj}-Y_j)}{\sqrt{\sum_{k=1}^{n}(Y_{ki}-Y_i)^2\sum_{k=1}^{n}(Y_{kj}-Y_j)^2}}$$

4. Calculating the variance contribution rate and cumulative variance contribution rate.

When the characteristic equation $|\lambda E-R|=0$, eigenvalues λ_i(i=1,2,…,p). Since R is a positive definite matrix, eigenvalues λ_i are positive, and arranged in order of size, that is, $\lambda_1\geq\lambda_2\geq\ldots\geq\lambda_p\geq 0$. The characteristic value is the variance of the principal component, which reflects the size of the object being evaluated and describe the role of each main component. Then, $|R-\lambda|U=0$ in order to determine the matrix of eigenvectors of U.

5. Extract is called before the m factor or principal components.

The essence of the Factor calculated contribution rate and cumulative contribution rates is to determine the number of principal components factor. The contribution rate factor is $\lambda_i/\sum_{j=1}^{p}\lambda_j$, then cumulative contribution rate/$\sum_{j=1}^{m}\lambda_j/\sum_{j=1}^{p}\lambda_j$.

Generally, the cumulative contribution rate is 80 - 95%. The eigenvalues $\lambda_1\geq\lambda_2\geq\ldots\geq\lambda_m$ corresponding 1, 2,…, p and m(m≥p) as a main component. SPSS 19.0 statistical software is used to calculate the eigenvalues of the contribution rate and cumulative contribution rate in order to determine the main ingredients.

6. That the cumulative contribution rate above 80%.

The compnent load calculation is used to determine the value of the principal component indicators. New economic significance of each main component gives a reasonable explanation.

7. Determination of the main component indexes.

By establishing a principal component index matrix $Z=(Z_{ij})_{n\times m}$, $\overline{Z}=(\overline{Z}_{ij})_{n\times m}$ with poor transform non-negative treatment.

$$\overline{z}_{ij}=\frac{z_{ij}-\min_j\{z_{ij}\}}{\max_j\{z_{ij}\}-\min_j\{z_{ij}\}},\quad z_{ij}\in[0\ 1]\ .$$

8. Non-negative processing of component index matrix.

The calculated item j No. i index value of the proportion of enterprises standardized indicators is as follows:

$$p_{ij}=\frac{\overline{z}_{ij}}{\sum_{i=1}^{m}\overline{z}_{ij}}(i=1,2,\ldots,n,\ j=1,2,\ldots,m)$$

9. Calculating the entropy and entropy weight.

Calculating the entropy for item j index, where k is Boltzmann's constant k>0, so that k=1/lnn:

$$e_{ij}=k\sum_{i=1}^{n}\ln p_{ij}(i=1,2,\ldots,n,\ j=1,2,\ldots,m),0\le e_j\le 1.$$

10. The comprehensive evaluation score is calculated.

Calculate the coefficient of variation in item j indicators. For item j index, the greater the difference in index $\overline{z}_{ij}$, the greater the weight right on the greater role of program evaluation. Make the difference coefficients g_j, $g_j=1-e_j$, when g_j is larger, the more importance of item j indicator. According to the calculated entropy. Entropy j indicators are (Zhou & Sun, 2013):

$$w_j=\frac{g_j}{\sum_{j=1}^{m}g_j}(1\le j\le m)$$

Calculation of the enterprise comprehensive performance scores:

$$S_i=\sum_{i=1}^{m}w_j p_{ij}(i=1,2,\ldots,n,\ j=1,2,\ldots,m).$$

Empirical Research

Research framework

As mentioned earlier, the objective of this study is to use Factor-Entropy analysis method to evaluate and examine the main factors of business costs of SMEs in Shanghai. The main factors of business cost include the basic accounting cost (commercial facilities and land costs, labor costs) and transaction cost (the efficiency of government operations, market-oriented, cost infrastructure, research and development capabilities) (Suand Sun, 2011). A research frame has been developed as illustrated and it is a simple linear model consisting of four categories. At the same time, the direct relationship of the capital market and the external environment for the establishment and development of SMEs in Shanghai is the dominant force. We first constructed the model of development from the perspective of the development of SMEs. In starting a business cost management, especially from people, objects, markets and government, four areas need to measur. Their evaluation index system is structured as follows thus explained.

However, policy-oriented, technological innovation, factor costs and markets indicators are the four sub-systems of SMEs in Shangai. The policy-oriented sub-systems includes three indicators: "the proportion of social credit system (X_1), the administrative fee income accounted for the proportion of local general budget revenue (X_2) and total tax revenue/GDP (X_3)"; the technological innovation subsystem comprised of three indicators: "million patents granted (X_4), the number of people with professional technology (X_5) personnel, workforce training number (X_6)"; the factor cost subsystem comprised of two indicators:" average wage (X_7) and fixed asset investment financial proportion of loans (X_8)"; While market operation subsystem comprised of two indicators:" expenditure / GDP (X_9) and the per capita investment in fixed assets (X_{10}) (Table 1).

Table 1. Shanghai SME Business Cost Index

System	No.	Meaning
Policy -oriented	X_1	Improve the ability of social security
	X_2	Government resource costs
	X_3	Government resource allocation capabilities
Technology Innovation	X_4	Knowledge resources
	X_5	Human Resources
	X_6	Human Resources
Factor cost	X_7	Human Resources
	X_8	Financial cost of capital resources
Market operation	X_9	Degree of development of the market
	X_{10}	Potential market growth rate

Sample and data

In the current study, based on the aforementioned evaluation structure, a comprehensive evaluation system that is more scientific and operable was carried out on business costs of Shanghai. The scope of the study has limitation within the scope of SMEs in Shanghai. Questionnaire protocol was used as the primary means of data collection. Based on the definition of the Statistical Information Center, small industries are defined as those having less than nine members; industries having fewer than 50 personnel can be called SMEs (Talebi *et al.*, 2007). We find a certain special object to research in Shanghai. According to the first batch of development funds intended for SMEs, 36 projects were supported for research on enterprise in Shanghai SMEs in China, 2013, with a total funding of 15.46 million RMB (http://www.sheitc.gov.cn). The categories of funds are divided into two. The first funds category is listed as foster SME restructuring project. There were 27 companies, such as Shanghai Lebo Electric shares limited company, Shanghai Xiao N G source of sea food and beverage management companies etc. Another main category of project is the broadening of the financial channels for SMEs. The companies should not be less than 9.

Among the 36 enterprises, 16 SMEs were randomly selected as the research object: Shanghai CITIC Health Pharmaceutical Co., Ltd., Shanghai Airlines Pentium construction Engineering Co., Ltd.,

Shanghai DESANO Pharmaceutical Co., Ltd., Shanghai Shensi enterprise Development Co., Ltd., Shanghai Blue-ray Technology Co., Ltd, Shanghai Manhattan Aluminum Co. Ltd., Dr Quran Optoelectronics Technology Co., Ltd., Ken-Buda technology Co., Ltd., Shanghai Lame Thailand CNC machine Co., Ltd, and Shanghai Galion new software Co., Ltd. Among the aforementioned enterprises, five of them were randomly selected as a sample (http://www.sheitc.gov.cn/gg/659905.htm). The survey data have a dedicated team to analyze the data evaluation. 16 SMEs were selected from Shanghai Ministry of Commerce Directory to receive mail survey with executives and managers of 36 SMEs in Shanghai. These firms were selected in accordance with Pelham's (1997) methodology. Out of 369 received questionnaires, 47 were useless and 13 were void due to multiple responses. Ultimately, 309 questionnaires (84%) were left, which were used for the statistical data analysis. The respondent characteristics are as shown in Table 2.

Table 2. Data Index of Business Cost Shanghai SME in 2012

Enterprise	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
LEBO Division	5.33	4.11	16.85	16.67	10.46	2.38	10.67	82.61	11.76	4.27
XIAO N G	0.96	0.67	8.70	7.44	1.24	0.69	82.74	16.14	1.57	-46.99
Blue-ray	1.07	0.75	6.27	6.99	12.59	1.70	74.29	16.35	14.96	-6.52
COSMOS	1.44	1.29	5.52	3.64	3.74	0.45	47.76	50.08	6.36	0.32
PENTIUM	1.12	0.54	4.93	17.71	7.77	2.07	59.54	31.83	18.44	12.48
Ken-Buda	1.32	1.19	4.51	5.36	2.47	0.32	50.88	47.65	14.94	7.13
DESANO	1.6	0.82	4.42	27.09	10.60	2.05	52.37	45.17	16.12	4.09
CITIC	1.79	1.54	6.35	2.96	9.63	1.01	51.35	46.49	35.57	11.80
SHENSI	1.68	1.38	13.84	15.48	17.53	2.13	49.30	50.06	7.32	9.72
HALEY	1.35	0.93	3.99	7.27	5.35	0.99	47.75	45.56	15.05	2.06
MAINE	1.36	0.75	2.75	18.34	8.53	1.22	61.99	35.21	16.45	2.24
WASH gardening	2.17	1.88	12.70	9.19	3.41	1.05	28.58	71.42	7.40	19.38
Flying Branch	5.31	4.73	5.70	5.56	3.07	0.31	13.55	86.15	13.00	1.88
Shires Man	2.69	1.96	2.81	4.92	4.15	0.62	25.65	45.47	21.84	0.90
BAOXIN	1.01	0.89	19.93	4.69	4.61	1.72	79.58	20.42	14.01	6.35
ZONKED	1.65	1.18	2.37	1.49	5.98	0.71	55.17	44.83	16.92	1.46

Computation of eigenvalues, the contribution rate and the cumulative contribution rate in determining the main ingredient

Here, 16 of Shanghai SMEs Business Cost data were analyzed in 2012 using SPSS statistical software automatically. This study, used the SPSS 21.0 software to complete the operation. The KMO sample measured value reached 0.861 on the average and the value by Bartlett test of sphericity is 32.218. The $\chi 2$ statistical significance probability value is 0.000, Bagozzi R P (1988) gives the standard KMO (KMO> 0.9: Good, 0.8 <KMO <0.9: Good, 0.7 <KMO <0.8: Average, 0.6< KMO <0.7): not suitable and KMO <0.5: not suitable, indicating that the data are relevant and more suitable for factor analysis (Chen *et al.*, 2005). The establishment of a factor loading matrix is shown in Table 3.

Table 3. Factor characteristic values, the contribution rate and the cumulative contribution rate

Component	Total	% of variance	Cumulative%
1	3.829	38.291	38.291
2	2.569	25.694	63.984
3	1.577	15.765	79.750
4	0.888	6.883	88.633
5	0.611	6.115	94.747
6	0.342	3.421	98.169
7	0.079	0.787	98.956
8	0.073	0.725	99.682
9	0.030	0.297	99.979
10	0.002	0.021	100.000

As shown in Table 3, for the cumulative contribution rate of the first three principal components of nearly 80%, m= 3 is obtained, that is, the three main components of indicators are taken to replace the original 10 financial indicators, these three main components of the indicators included the account information of the original 79.75%.

Tab.4 Factor loading matrix

	Component1	Component2	Component3
X_1	0.942	-0.033	-0.142
X_2	0.942	-0.125	-0.161
X_3	0.203	0.425	-0.592
X_4	0.042	0.761	-0.072
X_5	0.000	0.848	0.175
X_6	-0.018	0.962	-0.127
X_7	-0.954	0.068	-0.117
X_8	0.960	-0.047	0.022
X_9	0.032	0.053	0.879
X_{10}	0.421	0.372	0.584

Load capacity factor z_i is the correlation coefficient $R(z_i, x_i)$ of the original principal component index of x_i, the amount of factor loadings reveals the degree of correlation between the main components and the business cost ratio, the use may well explained the main ingredient economic significance. In determining the choice of m after the principal components, the key step is to formulate the economic interpretation of the main components, that is, to give new meaning to all the main ingredients. The principal component is a linear combination of the original cost of doing business indicators. The coefficients in the linear combination of the variables are of different sizes, they are of both positive and negative. In general, the absolute value of the ratio of cost of doing business in the linear combination coefficients indicate the property of their main ingredients to formulate a greater contribution to the cost of doing business if the rate of coefficient is quite few. Thus is acceptable that the main ingredient integrated several business cost ratio in nature. The interpretation of the factors of economic indicators are shown in Table 5.

Table 5. Interpretation of indicators of economic factors of indicators factors

Principal component index	Greater load capacity	Interpretation of indicators of economic factors
Z1	X_1, X_2, X_3, X_9, X_{10}	The impact of the external environment. Policies and market-oriented operation. Operational capacity
Z2	X_4, X_5, X_6	The impact and role of technological innovation. Innovation capacity
Z3	X_7, X_8	Factor cost. Necessary cost savings capacity

In this study, the process of factor analysis showed the intrinsic relationship between the three main factors and the 10 indicators. These three main factors influenced their indicators to organize as shown in Tale 6.

Table 6. Main factors is loading matrixes

Principal component index	Variance contribution rate	The principal component factor loadings greater load capacity indexes
Z1	34.656	X1, X2, X3, X9, X10
Z2	27.807	X4, X5, X6
Z3	10.685	X7, X8

The first factor contribution rate is significantly larger. Most of the larger load indicators and related status of the region's economies and markets development includes three indicators: "the proportion of social credit system (X1), the administrative fee income accounted for the proportion of local general budget revenue (X2) and local total tax revenue/ GDP (X3)"; while market operation subsystem includes two indicators: "expenditure/ GDP (X9) and the per capita investment in fixed assets (X10)". They are all called government and market factors.

The second factor contribution rate is 27.807. Technological innovation subsystem has three indicators, namely "people of patents granted (X4), the number of people with professional technology (X5), workforce training personnel (X6)". They can be called as a potential factor or technological factors.

The third elements factor cost subsystem has two indicators, namely "average wage (X7) and fixed asset investment in the proportion of loans to finance (X8)". They are the most basic elements of business costs, also known as elements of the factor.

Relational model between Z_i and the initial index X_i, which creates a primary component of the index value table

The first step involves the factor loading matrix rotation, which gets factor loadings rotated as shown in Table 7.

Table 7. Component Score Coefficient matrices

	Component1	Component2	Component3
X_1	0.251	-0.005	-0.075
X_2	0.254	-0.030	-0.090
X_3	0.065	0.185	-0.364
X_4	-0.003	0.298	-0.032
X_5	-0.025	0.324	0.125
X_6	-0.021	0.377	-0.064
X_7	-0.246	0.016	-0.088
X_8	0.250	-0.005	0.028
X_9	0.025	-0.005	0.557
X_{10}	0.080	0.133	0.383

In the second step, Based on Table 5, a model on principal component index between Zi and the initial indicators Xi can be built (Beltonv & Stewarttj, 2000):

Z_1 = 0.251×1 + 0.254×2 + 0.065×3- 0.003×43-0.025 ×53- 0.021×63-0.246×7 + 0.25×8 3-0.025×9 + 0.08×10

Z_2 = 0.005×1 3-0.03×2 + 0.185×3 + 0.298×4 + 0.324×5 +0.377×6 + 0.016×73-0.005×83- 0.005×9 + 0.133×10

Z_3 = 3-0.075×13- 0.09×2 3-0.364×33-0.032×4+ 0.125×53- 0.064×63-0.088×7 + 0.028×8 + 0.557×9 + 0.383×10

The third step, involves putting the data of Table 2 into the above equation to calculate index value of each factor component of the sample business cost in Shanghai enterprises, as shown in Table 8.

Table 8. each factor Index value on Business Cost of SME in Shanghai

Enterprise	Z_1	Z_2	Z_3
LEOBO Division	2.12253	1.43071	-0.96871
XIAO N G	-1.28672	-1.15184	-2.48199
Blue-ray	-1.09255	0.48836	-0.00329
COSMOS	-0.04700	-0.97931	-0.42748
PENTIUM	-0.67901	0.89246	0.72293
Ken Buda	-0.14728	-1.04478	0.41549
DESANO	-0.35257	1.37216	0.40608
CITIC Health	-0.0865	-0.15470	2.01947
SHENSI	0.01227	1.81431	-0.5135
HALEY	-0.25847	-0.45084	0.36416
MAINE	-0.63408	0.34383	0.51601
WASH gardening	0,86326	-0.05815	-0.39844
Flying Branch	2.21704	-1.11835	-0.20600
Shires Man	0.43537	-0.93154	0.86108
BAOXIN	-0.79889	0.40496	-0.90396
ZONKED	-0.26731	-0.85728	0.59815

Determination of the principal component index weights: Calculating and sorting the overall performance score

The first step: Based on Table 5, three new indicators used in the evaluation performed poorly in the conversion, with calculated item j indicators Dir i proportion enterprises index value.

The second step: the main component indexes of the calculated entropy valves and entropy weight are as shown in Table 9.

Table 9. Main factors of loading matrixes

Index	Z1	Z2	Z3	SUM
Entropy value	0.90254	0.87273	0.94640	2.72167
Entropy weight W_j	0.35015	0.45728	0.19257	1

The third step is to build a model based on a comprehensive assessment. The evaluation score is calculated and sorted according to the name of the enterprise: LEBO Division, XIAO N G, blue-ray, Manhattan, three Air Pentium, Ken Buda, DESANO, CITIC, SHENSI, HALEY, MAINE and, WASH gardening, Flying Branch, Shires Man, BAOXIN, ZOKED. Congregation S constant scores are shown in Table 9 and ranked as follows: 16, 10, 14, 6, 15, 5, 9, 4, 12, 2, 7, 8, 3, 11, 13, Table 10.

Table 10. Comprehensive evaluation scores of Business Cost of SME in Shanghai

Enterprise name	S value	Ranking
LEBO Division	0.0000	1
XIAO N G	0.05066	16
Blue-ray	0.03118	10
COSMOS	0.06906	14
PENTIUM	0.01257	6
Ken Buda	0.06906	15
DESANO	0.01257	5
CITIC Health	0.08338	9
SHENSI	0.05980	4
HALEY	0.09480	12
MAINE	0.10796	2
WASH gardening	0.06563	7
Flying Branch	0.06260	8
Shires Man	0.09984	3
BAOXIN	0.04924	11
ZONKED	0.03150	13

Evaluation and analysis

We put forward a comprehensive evaluation mode on a business cost of SME in shanghai with factor-entropy method. A comprehensive and sensitivity analysis procedure enhances this analysis by showing what happens when the weights are changed within given limits. Its basic principle to solve the existing problem cannot be of anti-empowerment, based on the sample of listed electronics companies ranking in the overall performance score (Table 10). Basically, in line with the actual situation, it can be divided into six levels. The area defined by S is greater than 0.08 points or more, which are among the top five: LEBO Division, MAINE, Shires Man, SHENSI and DESANO; S greater than 0.06 comprise of three areas, that is,

PENTIUM, WASH gardening and Flying Branch; S greater than 0.05 comprise of two, namely CITIC Health and Blue-ray; S is greater than 0.04 has two: HALEY and BAOXIN; S is greater than 0.03 comprise of two, namely ZONKED and COSMOS; While S is less than 0.03 ss Division have the highest evaluation score value, far higher than other companies, which means that it has operational capability, innovation capability and the ability to save a good level, indicating that the current state of development is good. As for the last row of the Xiao N G, the index is not ideal and its control of business costs is not ideal, it is influenced by the government and the market is relatively large, it has innovation ability, but the ability to save is minimum. Development of BAOXIN affected the markets, the government. Moreover, it has the largest scientific and technological innovation. Its position and size give an indication on the difficulty of the decision problem. Main ingredients-entropy analysis is mainly by screening, with relatively few financial indicators to comprehensively reflect the additional financial information. The method overcomes the cost of doing business index of subjective weight limitations and to some extent, improves the quality of business cost comprehensive evaluation of SME in Shanghai. Therefore, it can said that the performance evaluation method is better and as such, should be widely applied. Since the calculation of the entropy index is used in a proportion of sample enterprises with sum of the same index, there is no impact dimension and standardized treatment as a result of the negative data, but the data required for translation need to be non-negative during processing in order to avoid meaningless when seeking entropy numbers (Johannes, 2011). In practical applications, combined with the actual situation can be corrected to adjust the evaluation index system. Therefore, it can be said that the evaluation results more real.

The results provide a framework for companies and researchers to approach business cost in a more systematic way. The factor- entropy method function by measuring the index information size in order to evaluate simultaneously, the accuracy and size of index information. The more conservative numerical results of important rankings, which

involve the more choices, can be viewed as faulty identification under a certain expected value. The aforementioned method will lead to intense information about business cost research objective.

Conclusion

This study was carried out to evaluate the application of factor-entropy method on the cost of doing business for SME in Shanghai, which is an original multi-factors decision-making method. It proposes the principle for the comprehensive evaluation of multi-factor information such as price and precision, and meets the requirements of a variety of factors in decision-making on information for comparison. However, the proposals to help in the development of SMEs and management of business costs were found in this study. In general, this study shows that the rapid rise of significant commercial facilities and land, labor costs in Shanghai and transaction costs due to government implementation of a number of practical policies, causes operational efficiency, market-oriented, and the degree of information, infrastructure and R&D capabilities and other aspects to improved significantly, and to a certain extent, reduce the cost of doing business. Decision-makers preference information on the cost of using the system in Shanghai SME business performance evaluation of economy, technology, policy and market environment, help to provide decision support. At the same time, the degree of market development of the tertiary industry and high-tech manufacturing industries, intellectual property rights and other aspects of R&D capabilities increase in business costs, can be used as a threshold for enterprises to begin.

Wherever the random study is involved, entropy was not used. The main contribution of this study on business cost is the provision of a theoretical basis, and initially test the underlying assumptions, but there are still some drawbacks. Several limitations are acknowledged here. From the methodological point of view, this study's limitation is attributed to the data that rely entirely on questioners. For example, the cost of doing business relationship model is yet to be constructed in order to expand the scope of the study. In addition, this article

provides several number of factors that cannot be measured by statistics and they were not included in the assessment system, thereby affecting the comprehensive evaluation system, pending further study. Further research in this area is required to yield new and useful insights.

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