Evaluation of the Business Environment in Dalian City under the Factor Analysis and Entropy Value Method

Dahai Zhang[1,a*], Xiaoting Yin[2,b], Huizhen Yan[1,c]

{zhang_dh@dlpu.edu.cn[a]; 906956676@qq.com[b], yanhz@dlpu.edu.cn[c]}

Department of Basic Courses Teaching, Dalian Polytechnic University,Dalian, 116034, China[1]
Administrative Committee of Dalian High-tech industrial zone, Dalian, 116023, China[2]

Abstract. Based on the Factor Analysis and Entropy Mothod, this paper establishes the business environment evaluation system of Dalian, and calculates the business environment score of Dalian from 2010 to 2021. Results show that: in the past ten years, Dalian's business environment has been continuously optimized; to be specific, strengthening infrastructure construction, improving the overall level of urban economy and social welfare are the key factor to improve Dalian's business environment.

Keywords: Business environment, Factor analysis, Entropy method.

1 Introduction

Business environment refers to the sum of all external conditions that affect the entire business process of an enterprise (including all links from start-up, operation to closure) [1]. It is especially crucial for the survival and development of small and medium-sized enterprises, and directly affects the investment decision, start-up cost, profitability, operation mode, cancellation or closure decision and other aspects of an enterprise. According to its connotation, business environment can be divided into business system environment, business investment environment, business tax environment, business rule of law environment and business culture environment[2]. The evaluation index system and theory of doing business environment are mainly based on the "Global Doing Business Report" released by the World Bank for the first time in 2003, which evaluates enterprises from five aspects. In terms of impact effect, the business environment has an impact on macroeconomic and microeconomic aspects such as economic development, trade level, industry development, foreign direct investment, corporate decision-making behavior, corporate rent-seeking, productivity and labor wage distortion[3-7]; In terms of research methods, the early literature mainly focuses on qualitative analysis of issues related to business environment, while quantitative analysis is less, and there are few literatures based on empirical analysis[7-12]. Zhang Dahai et [2] combined the data from the World Bank's Doing Business Report and important macro data, built a business environment index evaluation system, used factor analysis and other methods to conduct modeling, and conducted empirical research on China's business environment data.

In recent years, research methods based on empirical analysis have become an important method in the study of business environment. In addition, the existing literature mainly focuses on the study of business environment at the national and local levels, and there are relatively few micro-studies on the business environment of individual cities. Therefore, this

paper first establishes the urban business environment evaluation system, evaluates the business environment of Dalian quantitatively based on factor analysis and entropy method,providing policy basis for the construction of Dalian's business environment.

2 Construction of evaluation index system and evaluation model

2.1 Construction evaluation index system

According to the data of National Bureau of Statistics and Dalian Bureau of Statistics, four first-level indicators are set, namely Government and Law (GOV), Economy (ECO), Society and Culture (SCI), and Technology (TECH). For each first-level indicator, four representative indicators are selected as second-level indicators, as shown in Table 1.

Table 1 Dalian business environment evaluation index system

first-level indicator	Index description	second-level indicators	Index description and selection reasons
Government and Law(GOV)	Government administrative efficiency and attitude, relevant legal guarantee, and fiscal revenue and expenditure status, etc	Tax revenue(TAX)	Includes the local tax, national tax and customs tax in 2016 and the previous years, which is used to reflect the business tax burden of the enterprise.
		Local general public budget expenditure(EXP)	Includes expenditure on education, health care, housing security, energy conservation and environmental protection, and is used to reflect the government's expenditure on building infrastructure and improving people's livelihood.
		Freight transportation turnover(FRV)	The volume of freight transportation turnover achieved by three modes of transportation, including road, water and civil aviation, is used to reflect the convenience of urban transportation.
		Newly registered enterprises of all types(REG)	Used to comprehensively reflect the administrative convenience reflected in the operation process of enterprises such as opening and closing.
Economy(ECO)	Economic development level, social and economic structure, population and financing facilities	Total retail sales of consumer goods(SRG)	Including retail sales of goods and food and beverage income, used to comprehensively reflect the degree of economic prosperity of the city.
		Birth population(BP)	Used to comprehensively reflect the quality of urban life.
		Per capita disposable income(PGDP)	Used to reflect the income of urban residents.
		Balance of deposits and loans of financial institutions(BDL)	Used to comprehensively reflect the development of urban finance.
Society and	Social mobility,	Days of good air(DGE)	Used to reflect urban climate environment and livability.

Culture(SCI)	demographics, social security and education levels	Art troupe performance(AST)	Used to reflect the cultural life of the city
		Beds available in various health institutions(PB)	Used to reflect the capacity and level of urban medical reception
		New urban jobs(NUJ)	Used to reflect a city's attractiveness and potential for value creation.
Technology (TECH)	National science and technology system, science and technology level and science and technology policy	Number of invention patent applications(PAT)	The number of patent applications, including the sum of the number of applications for inventions, utility models and designs, is used to reflect innovation capability.
		Revenue from scientific research and technical services(STR)	Used to reflect the ability of scientific research institutions to create value.
		Students of undergraduate and junior college (SUC)	Used to reflect the wealth of the supply of skilled personnel.
		Fixed Internet broadband access users(FIA)	Used to reflect the basis of urban development.

2.2 Data source and description

The data in this paper are from public websites such as National Bureau of Statistics, Dalian Municipal Bureau of Statistics, Dalian United Front Work Department and China Internet Information Center, and the data period is 2010-2021. The data of TAX revenue (TAX) from 2010 to 2016 is the sum of local tax revenue, national tax revenue and customs revenue. Since there is no statistical data in some years, the number of invention patent applications (PAT) is selected as an alternative indicator.

2.3 Construction of the evaluation model

Firstly, factor analysis is used to analyze the secondary evaluation index. In this paper, 12 annual data are selected, sample size is taken $m = 12$, and set the number of common factors after screening is $n(n < m)$, x_{ij} is the factor score of the common factor of year i item j, where $i = 1,2,\cdots,m$; $j = 1,2,\cdots,n$. Then, the entropy method is used to assign weight to the common factors. The data is positive as shown in formula (1), the weight of index value is calculated as shown in formula (2), the entropy is calculated as shown in formula (3), the coefficient of index difference is calculated as shown in formula (4), and the weight of index is calculated as shown in formula (5). Finally, the assessment model of Dalian business environment is obtained, as shown in formula (6). Where, n is the number of common factors, x_{ij} is the score of common factors, and w_j is the weight of each factor index. According to Dalian Business environment evaluation model, the comprehensive score and ranking of Dalian business environment from 2010 to 2021 are calculated.

$$X'_{ij} = \frac{x_{ij} - \min(x_{1j}, x_{2j},\ldots,x_{mj})}{\max(x_{1j}, x_{2j},\ldots,x_{mj}) - \min(x_{1j}, x_{2j},\ldots,x_{mj})} \tag{1}$$

$$Y_{ij} = X'_{ij} \bigg/ \sum_{i=1}^{m} X'_{ij}, 1 \le j \le n \qquad (2)$$

$$e_j = -\frac{1}{\ln m} \sum_{i=1}^{m} Y_{ij} \ln Y_{ij} \ln Y_{ij}, 1 \le i \le m, 0 \le e_j \le 1 \,(\text{when } Y_{ij} = 0, \quad e_j = 0) \qquad (3)$$

$$g_j = 1 - e_j, 0 \le g_j \le 1 \qquad (4)$$

$$w_j = g_j \bigg/ \sum_{j=1}^{n} g_j, 0 \le g_j \le 1, w_1 + w_2 + \cdots + w_j = 1 \qquad (5)$$

$$F_i = \sum_{j=1}^{n} X_{ij} * w_j, i = 1, 2, \cdots, m \qquad (6)$$

3 Empirical analysis of Dalian business environment

Firstly, factor analysis is used to reduce the dimension of the secondary indicators of Dalian business environment, extract the common factors, and determine the proportion of common factors. Then the entropy method is used to re-weight the common factors to improve the objectivity of the multi-index comprehensive evaluation.

3.1 Evaluation index factor extraction

First, check whether the original variable is suitable for factor analysis. According to the correlation coefficient matrix of the calculated secondary index data, the secondary index has a high correlation, which is conducive to the screening of common factors. The results showed that the KMO test value was 0.731 (>0.5), indicating that the secondary index was suitable for factor analysis. In addition, the observed value of Barflett sphericity test statistic is 261.012, and the corresponding adjoint probability is 0.000, which also indicates that the correlation coefficient matrix is significantly different from the identity matrix, and the second-level index is suitable for factor analysis.

The total explanatory variance of the calculated factor analysis is shown in Table 2. Among the 16 secondary index variables, 3 common factors are finally selected, and the cumulative contribution rate of the 3 common factors reaches 91.019% (the first factor can explain 56.961% of the original variable, and the second factor can explain 23.542% of the original variable, The third factor can explain 10.515% of the original variable), indicating that the 3 common factors contain most of the information of the original variable, and the factor analysis results are good.

Table 2 Total variance interpretation

component	Initial eigenvalue			Extract the sum of squared loads			Sum of the rotating load squares		
	total	variance percentage	accumulation %	total	variance percentage	accumulation %	total	variance percentage	accumulation %
1	9.114	56.961	56.961	9.114	56.961	56.961	5.208	32.548	32.548
2	3.767	23.542	80.503	3.767	23.542	80.503	4.921	30.759	63.307

3	1.682	10.515	91.019	1.682	10.515	91.019	4.434	27.711	91.019
4	.531	3.316	94.335						
5	.357	2.229	96.564						
6	.205	1.281	97.845						
7	.168	1.048	98.893						
8	.107	.670	99.563						
9	.031	.197	99.760						
10	.021	.131	99.890						
11	.018	.110	100.000						
12	7.127E-16	4.455E-15	100.000						
13	5.237E-16	3.273E-15	100.000						
14	1.606E-16	1.004E-15	100.000						
15	-1.587E-16	-9.920E-16	100.000						
16	-3.904E-16	-2.440E-15	100.000						

Extraction method：principal component analysis.

The computed rotational component matrix is shown in Table 3. Common factor 1 has a large load on all 13 variables. Common factor 2 has a large load on the four variables, which are freight transportation turnover(FRV), total retail sales of consumer goods (SRG), birth population (BP), and days of good air (DGE), which mainly represent the basic livelihood indicators of Dalian, so it is named "livelihood level factor". Common factor 3 has a large load on one variable. That indicator is new urban jobs (NUJ), which represents a factor of social stability, so it is named "government management factor".

According to the total variance interpretation data, the variance contribution rate of infrastructure construction factor is 56.961%, the variance contribution rate of people's livelihood factor is 23.542%, and the variance contribution rate of government management factor is 10.515%. From the above analysis, we can draw the following conclusions: Infrastructure construction in Dalian is an important factor affecting the business environment. Meanwhile, continuous improvement of people's livelihood, expansion of domestic demand, improvement of urban environment, employment protection and promotion, and maintenance of social stability are also important aspects of Dalian's business environment construction.

Table 3 Rotational component matrix

second-level indicators	component			second-level indicators	component		
	1	2	3		1	2	3
tax revenue(TAX)	-.854	.060	.449	Days of good air(DGE)	-.217	-.799	-.410
local general public budget expenditure(EXP)	.605	.447	.506	art troupe performance(AST)	-.830	.088	-.319
freight transportation turnover(FRV)	-.701	.690	-.074	Beds available in various health institutions(PB)	.945	.308	-.009
Newly registered enterprises of all types(REG)	.922	.248	-.238	New urban jobs(NUJ)	-.613	-.023	.744

Total retail sales of consumer goods(SRG)	.227	.877	-.307	Number of invention patent applications(PAT)	.789	-.504	.008
Birth population(BP)	-.205	.871	.011	Revenue from scientific research and technical services(STR)	.811	-.375	.377
Per capita disposable income(PGDP)	.915	.384	-.074	Students of undergraduate and junior college (SUC)	.898	-.001	.304
Balance of deposits and loans of financial institutions(BDL)	.900	.309	-.034	Fixed Internet broadband access users(FIA)	.919	-.345	-.064

Extraction method：Principal component analysis.

a. 3 components were extracted.

3.2 Evaluation and analysis

The index of the calculated common factor was re-weighted by the entropy method, and was substituted into the Dalian Business environment evaluation model to obtain the comprehensive score and ranking of Dalian business environment from 2010 to 2021, as shown in Table 4.

Table 4 The score and ranking of Dalian business environment from 2010-2021

Year	Infrastructure factor	Livelihood level factor	Government management factor	Composite score	Comprehensive ranking
2010	125629.5573	-76392.6864	-105883.9785	1.00	12
2011	139647.8074	-85765.161	-115949.5147	1.11	10
2012	183736.3174	-116436.0311	-155185.9341	1.44	5
2013	181430.7977	-113394.4287	-152434.7296	1.43	6
2014	169580.1614	-102024.8037	-139038.0123	1.37	7
2015	153180.4412	-88863.6027	-124776.7109	1.25	8
2016	127209.0159	-69659.5174	-100029.9134	1.07	11
2017	146373.1782	-80538.39686	-117033.7708	1.23	9
2018	186231.7208	-106928.8656	-153443.8565	1.53	4
2019	209764.6481	-122956.5556	-174376.2261	1.70	3
2020	256931.1813	-157792.0184	-219113.5326	2.03	2
2021	280543.9211	-172982.38	-242714.7446	2.20	1

From Table 2, the index weight of infrastructure factor is 0.56961, indicating that urban infrastructure plays a decisive role in influencing the comprehensive score of Dalian's business environment. Therefore, to improve the overall score of Dalian's business environment, it is still necessary to invest major efforts in infrastructure construction. In addition, the weight of government management factors is 10.515%, so improving Dalian's business environment and maintaining social stability cannot be ignored.

From Table 4, we can see that since 2018, Dalian's business environment score has increased rapidly, indicating that Dalian's business environment has been optimized year by year in recent years. In 2016, Dalian's business environment score was low. Further analysis shows that the total tax revenue and the amount of new urban employment in Dalian dropped significantly compared with the previous year, resulting in a significant decline in the comprehensive score. From 2012 to 2017, Dalian's business environment score continued to decline, and the comparative data found that the total tax revenue of the corresponding year declined year by year, although the number of newly registered enterprises increased year by

year, the amount of new employment declined year by year. Since 2018, the amount of new employment has rebounded rapidly and increased year by year, and the corresponding annual business environment score has increased year by year, which is worthy of attention.

On the whole, Dalian has achieved remarkable results in the construction of business environment in recent years, but the growth rate of the comprehensive score fluctuates significantly, indicating that in the construction of business environment, it is necessary to consider the random factors of the market and ensure the comprehensiveness and sustainability of the construction measures of business environment.

4 Conclusions

Based on the four dimensions of government and law (GOV), economy (ECO), society and culture (SCI) and technology (TECH), this paper constructs a comprehensive evaluation model of Dalian's business environment. Factor analysis method is used to screen common factors and calculate their scores for the secondary indexes of the four selected factors. Entropy method is used to assign weights to common factors and get thecomprehensive score and ranking of Dalian business environment from 2010 to 2021 are obtained. The results show that: (1) the contribution weight of infrastructure factor to Dalian's business environment score is 56.961%, the contribution weight of people's livelihood factor to Dalian's business environment score is 23.542%, and the contribution weight of government management factor to Dalian's business environment score is 10.515%. The above data shows that strengthening infrastructure construction, improving the overall level of urban economy and social welfare are still the key work to improve Dalian's business environment. On the other hand, livelihood factors, including stabilizing the consumer market, expanding domestic demand, and improving the employment environment, should also be an important focus for optimizing the business environment. (2) Since 2018, Dalian's business environment score has continued to increase, which is consistent with the data released by the Municipal government of Dalian that it has been rated as China's benchmark city for international business environment construction for two consecutive years.

References

[1] Zhang Guoyong, Lou Chengwu. Research on the optimization of business environment based on institutional embeddings —Take Liaoning Province as an example [J]. Journal of Northeastern University (Social Science Edition), 2018,20 (3): 277-283.

[2] Zhang Dahai, Zhu Zhichuan. Evaluation of China's business environment under factor analysis and entropy method [J]. Accounting Monthly, 2019 (18): 124-130.

[3] Dong Zhiqiang, Wei went into the sea, Tang Canqing. Institutional soft environment and economic development — Based on the experience of business environment in 30 major cities [J]. Management World, 2015 (4): 9-20.

[4] Adrian Corcoran，Robert Gillanders. Foreign direct investment and the ease of doing business[J]．Review of World Economics，2015(1):103-126.

[5] Zhang Jiping, Luo Wenping, Liu Yongliang. Research on the influence of Business Environment on the linkage development of manufacturing industry and logistics industry [J]. Journal of Management, 2017 (5): 25-33.

[6] Yang Zhiyong, Wen Feng'an. The value, difficulties and strategies of optimizing the business environment [J]. Reform, 2018 (10): 5-13

[7] Zhou Chao,Liu Xia, Gu Zhuan. Business environment and China's foreign direct investment — is based on the perspective of investment motivation [J]. International trade issues, 2017 (10): 143-152.

[8] Xia Xuehou,Tan Qingmei, Bai Junhong.Business environment, business rent-seeking and market innovation —Empirical evidence from the business environment survey of Chinese enterprises [J]. Economic Research, 2019 (4): 84-98.

[9] Canare, Teistanl. The effect of ease of doing business on firm creation[J]. Annals of economics & finance,2018,19(2):555-584.

[10] Amankwah-amoah J,Osabutey E L C, Egbetok-un A. Contemporary challenges and opportunities of doing business in Africa: The emerging roles and effects of technologies[J]. Technological forecasting and social change,2018,131:171-174.

[11] Zhang Sanbao, Kang Bicheng, Zhang Zhixue, Business environment evaluation in Chinese provinces: Index system and quantitative analysis, Economic Management. 2020,42(04),5-19

[12] Zeng Hui, Zhang Lei, Wang Wan and Guizhou, business environment evaluation and change trend analysis of countries along the Belt and Road route, Asia-Pacific economy. 2023(04):1-14