Evaluation and Comparative Study of Industrial Competitiveness in the Beijing-Tianjin-Hebei Area

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Abstract With the industrial competitiveness in the Beijing-Tianjin-Hebei area in 2013 as the object of study, this paper uses principal component analysis to evaluate and compare the industrial competitiveness in the Beijing-Tianjin-Hebei area, in order to provide reference for Beijing-Tianjin-Hebei joint development. The results show that in terms of industrial structure competitiveness, Beijing > Tianjin > Hebei; in terms of agricultural competitiveness, Tianjin > Beijing > Hebei; in terms of industrial competitiveness, Tianjin > Beijing > Hebei; in terms of service industry competitiveness, Tianjin > Beijing > Hebei; in terms of high-tech industry competitiveness, Beijing > Tianjin > Hebei. It is suggested that Beijing-Tianjin-Hebei should further optimize industrial structure, and develop modern service industry. In the Beijing-Tianjin-Hebei joint development, Hebei should focus on the development of agriculture, Tianjin should focus on the development of industry, and Beijing should focus on the development of high-tech industry.

Key words Beijing-Tianjin-Hebei, Industrial competitiveness, Principal component analysis

1 Introduction

Since the reform and opening up, the Yangtze River Delta and Pearl River Delta economic zones have developed by leaps and bounds. By contrast, the Beijing-Tianjin-Hebei area is far behind in terms of economic aggregate, degree of opening to the outside world, marketization process and regional integration. On March 5, 2014, Premier Li Keqiang pointed out in Government Work Report that there was an urgent need to strengthen the economic cooperation in the Bohai Rim region and the Beijing-Tianjin-Hebei area. On April 30, 2014, the CPC Central Committee Political Bureau approved *Beijing-Tianjin-Hebei Joint Development Plan*, putting Beijing-Tianjin-Hebei joint development as a major strategic decision of the Party Central Committee. The interprovincial industrial competitiveness is not only a hot issue of national development since the reform and opening up, but also a classic problem in economic geography and economics[1]. Scientific and rational evaluation of industrial competitiveness in the Beijing-Tianjin-Hebei area can help to further define the status of various industries and various places in the Beijing-Tianjin-Hebei area, and provide a basis for the regional industrial development, which is of great significance to exploring the industrial division of labor in the Beijing-Tianjin-Hebei area, and enhance the overall industrial competitiveness of the Beijing-Tianjin-Hebei area. Based on the statistics about the Beijing-Tianjin-Hebei area in 2013, this paper evaluates and compares the industrial competitiveness in the Beijing-Tianjin-Hebei area, in order to provide a reference for Beijing-Tianjin-Hebei joint development.

2 Literature review

At present, domestic scholars mainly use principal component analysis to evaluate the industrial competitiveness of different provinces. Li Zhanguo *et al.*[2] (2007) use principal component analysis to analyze the industrial competitiveness of Xinjiang, and the results show that Xinjiang's competitive industries are mainly labor-intensive industries and resource-intensive industries. Zhang Jinghua[3] (2009) uses principal component analysis to evaluate the industrial competitiveness of the western provinces and autonomous regions from the dynamic and static perspective. Du Xiaowu *et al.*[4] (2010) use principal component analysis to evaluate the industrial competitiveness of Xinjiang's oil and gas, and confirm the competitive position of Xinjiang's oil and gas in China's oil and gas industry. Zhang Liangang[5] (2011) uses factor analysis, principal component analysis, entropy value method, cluster analysis and analytic hierarchy process to evaluate and compare the circulation industry competitiveness of the eastern and western provinces. In the study of coal industry competitiveness, Sun Hui *et al.*[6] (2012) use principal component analysis to build the coal industry competitiveness index system from realistic competitiveness and potential competitiveness. Sun Dongqi[1] (2013) uses principal component analysis, location quotient and unitary linearity regression to analyze the industrial competitiveness model structure in Jiangsu Province and Shandong Province. Wu Shanshan *et al.*[7] (2014) establish the provincial marine industry competitiveness evaluation index system, use set pair analysis and principal component analysis to measure the marine industrial competitiveness, and make hierarchical division of coastal provinces according to the score. Wu Kefan[8] (2014) uses PCA-TOPSIS method to conduct horizontal comparison of Guangdong and other coastal provinces, and get the ranking of Guangdong in terms of comprehensive marine industry competitiveness among the coastal provinces. It can be seen that the application of principal component analysis in the study of provincial industrial competitiveness has been very common, and the method is also mature.

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Domestic scholars have done a lot of studies on the industries in the Beijing-Tianjin-Hebei area. From the perspective of regional integration, Zhang Xiaowei *et al.* [9] (2009) evaluate the high-tech industry competitiveness in the Beijing-Tianjin-Hebei area. Based on economic weight correction of Boarnet formula, Ren Chongqiang *et al.* [10] (2012) use shift-share space model to calculate the factor change in primary, secondary and tertiary industries in the Beijing-Tianjin-Hebei area during 2002—2005, 2006—2009. From the perspective of industry cluster, Li Jiahui[11] (2012) uses factor analysis to measure and evaluate the equipment manufacturing industry level in the Beijing-Tianjin-Hebei area. Chu Junling[12] (2014) uses shift-share analysis to study the competitive industries in the Beijing-Tianjin-Hebei area. Li Junyan[13] (2015) studies the joint industrial development in the Beijing-Tianjin-Hebei area. Fu Wang[14] (2015) uses location entropy grey relational analysis and SSM model to measure and analyze the industrial competitiveness of major cities in the Beijing-Tianjin-Hebei area. Yin Zheng[15] (2015) studies the industrial division of labor in the Beijing-Tianjin-Hebei area, and uses industry specialization index and location entropy grey relational analysis to measure the industrial division of labor and its evolution in the Beijing-Tianjin-Hebei area during 2004, 2008 and 2012. It can be seen that there is no comparative study on the industrial competitiveness in the Beijing-Tianjin-Hebei area, so this paper uses principal component analysis to evaluate and compare the industrial competitiveness in the Beijing-Tianjin-Hebei area, which is not only of important theoretical significance, but also of important practical significance.

3 Research methods and evaluation indicator system

3.1 Research methods Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. PCA is mostly used as a tool in exploratory data analysis and for making predictive models. It is also a method in mathematics for dimensionality reduction[16]. (i) Normalizing the original indicator data. p-dimensional random vector $x=(x_1,x_2,...,x_p)^T$ is acquired, and n samples $x_i=(x_{i1}, x_{i2},...,x_{ip})^T$, $i=1, 2, \cdots, n$, $n>p$. The sample matrix is built, and the sample array elements are normalized as follows: $Z_{ij}=\frac{x_{ij}-\overline{x_j}}{s_j}$, $i=1,2,...,n$; $j=1,2,...,p$, where $\overline{x_j}=\frac{\sum_{i=1}^{n}x_{ij}}{n}$, $s_j^2=\frac{\sum_{i=1}^{n}(x_{ij}-\overline{x_j})^2}{n-1}$. The normalized matrix Z is obtained. (ii) Calculating correlation coefficient matrix on Z. $R=[r_{ij}]_p xp=\frac{Z'Z}{n-1}$, where $r_{ij}=\frac{\sum z_{kj}\cdot z_{kj}}{n-1}$, $i, j=1,2,...,p$. (iii) Solving the characteristic equation of sample correlation matrix R ($|R-\lambda I_p|=0$) to get p characteristic roots and determine the principal component. m value is determined based on $\frac{\sum_{j=1}^{m}\lambda_j}{\sum_{j=1}^{p}\lambda_j}\geqslant\partial$, and ∂ is generally 85% (making the information utilization rate reach more than 85%). For each λ_j, $j=1, 2,..., m$, the equation is solved to get $Rb=\lambda_j b$ and unit eigenvector of b_j^0. (iv) Converting the normalized indicator variable into principal component $U_{ij}=z_i^T b_j^0$, $j=1, 2, ..., m$. U_1 is called the first principal component; U_2 is called the second principal component; U_p is called the p-th principal component. (v) Evaluating m principal components. The weighted sum is calculated on m principal components to get the final evaluation value, and the weight is the variance contribution rate of each principal component.

3.2 Establishment of Beijing-Tianjin-Hebei industrial competitiveness indicator system In Chinese Provincial Economic Competitiveness Development Report, Professor Li Jianping establishes a relatively sound scientific overall provincial economic competitiveness evaluation indicator system, to evaluate the comprehensive economic competitiveness in mainland China's 31 provincial-level regions[17]. Referring to Professor Li Jianping's provincial economic competitiveness evaluation indicator system, it is believed that the industrial competitiveness in the Beijing-Tianjin-Hebei area includes five elements, namely industrial structure competitiveness, agricultural competitiveness, industrial competitiveness, service industry competitiveness, and high-tech industry competitiveness. The Beijing-Tianjin-Hebei industrial competitiveness indicator system is established, including 5 second-level indicators and 33 third-level indicators, as shown in Table 1.

4 Beijing-Tianjin-Hebei industrial competitiveness measurement and comparative analysis

4.1 Measurement

4.1.1 Calculating eigenvalue and contribution rate of R. This paper selects the 2013 data about the Beijing-Tianjin-Hebei area as sample indicators, and the relevant data are from *China Statistical Yearbook*, *Beijing Statistical Yearbook*, *Tianjin Statistical Yearbook*, *Hebei Statistical Yearbook*, and *China Statistical Yearbook on Science and Technology*. To facilitate the calculation and comparison, we first normalize the relevant indicator value, and then use factor analysis to analyze data by SPSS. 20, to get eigenvalue and contribution rate of R. Results show that the variable correlation matrix has two characteristic roots (22.14, 10.86), the contribution rate is 67.08% and 32.92%, respectively, and the cumulative contribution rate is exactly 100%, so the two principal factors provide the main information that can be expressed by original data, as shown in Table 2.

4.1.2 Establishing factor loading matrix. Factor loading matrix is established for the extracted principal factors F_1 and F_2, as shown in Table 3. According to Table 2 and Table 3, the rate of contribution of the first principal factor F_1 to Beijing-Tianjin-Hebei industrial competitiveness is 67.08%, accounting for the major proportion. Rural residents' per capita disposable income C_7, per capita service industry added value C_{22}, profit-tax rate of the retail enterprises above designated size C_{23}, profit-tax rate of the food and beverage enterprises above designated size C_{25}, and tourism foreign exchange income C_{26}, have a great load interpretation ability. Per capita service industry added value C_{22}, profit-tax rate of the retail enterprises above designated size C_{23}, profit-tax rate of the food and beverage enterprises above designated size C_{25}, and tourism foreign exchange income C_{26}, primarily reflect the competitiveness of the service industry. Rural residents' per capita disposable income C_7 reflects agricultural competitiveness. Clearly, the service industry competitiveness is an important basis of Beijing-Tianjin-Hebei industrial competitiveness, and agricultural competitiveness plays an important role in evaluating Beijing-Tianjin-Hebei industrial competitiveness. The rate of contribution of the second principal factor F_2 to Beijing-Tianjin-Hebei industrial competitiveness is 32.92%, occupying a minor share. Growth rate of agricultural added value C_5, per capita industrial added value C_{13}, contribution rate of total assets of the industrial enterprises above designated size C_{15}, and asset-liability ratio of the industrial enterprises above designated size C_{17}, have a great load interpretation ability. Per capita industrial added value C_{13}, contribution rate of total assets of the industrial enterprises above designated size C_{15}, asset-liability ratio of the industrial enterprises above designated size C_{17}, mainly reflect the industrial competitiveness. Growth rate of agricultural added value C_5 mainly reflects agricultural competitiveness. Obviously, industrial competitiveness and agricultural competitiveness also play an important role in evaluating the Beijing-Tianjin-Hebei industrial competitiveness.

Table 1 Beijing-Tianjin-Hebei industrial competitiveness indicator system

Second-level indicators	Third-level indicators
Industrial structure competitiveness	Proportion of primary industry C_1 // %
	Proportion of secondary industry C_2 // %
	Proportion of tertiary industry C_3 // %
Agricultural competitiveness	Agricultural added value C_4 // 10^8 yuan
	Growth rate of agricultural added value C_5 // %
	Per capita agricultural added value C_6 // yuan
	Rural residents' per capita disposable income C_7 // yuan
	Total agricultural machinery power C_8 // 10^4 kW
	Rural per capita electricity consumption C_9 // 10^4 kWh
	Local fiscal spending on farming, forestry and water conservancy C_{10} // 10^8 yuan
Industrial competitiveness	Industrial added value C_{11} // 10^8 yuan
	Growth rate of industrial added value C_{12} // %
	Per capita industrial added value C_{13} // yuan
	Total industrial assets of the industrial enterprises above designated size C_{14} // 10^8 yuan
	Contribution rate of total assets of the industrial enterprises above designated size C_{15} // %
	Working capital turnover rate of the industrial enterprises above designated size C_{16}
	Asset-liability ratio of the industrial enterprises above designated size C_{17} // %
	Industrial cost ratio of the industrial enterprises above designated size C_{18} // %
	Industrial product sale rate of the industrial enterprises above designated size C_{19} // %
Service industry competitiveness	Service industry added value C_{20} // 10^8 yuan
	Growth rate of service industry added value C_{21} // %
	Per capita service industry added value C_{22} // yuan
	Profit-tax rate of the retail enterprises above designated size C_{23} // %
	Profit-tax rate of the wholesale enterprises above designated size C_{24} // %
	Profit-tax rate of the food and beverage enterprises above designated size C_{25} // % Tourism foreign exchange income C_{26} // 10^8 yuan
High-tech industry competitiveness	Number of high-tech industrial enterprises C_{27}
	High – tech industry's main business income C_{28} // 10^8 yuan
	Number of valid invention patents about high-tech industry C_{29}
	Total imports and exports of high-tech products C_{30} // \$ 10^6
	R&D personnel C_{31} // person · year
	Share of R&D expenditure in GDP C_{32} // %
	Technology market turnover C_{33} // 10^8 yuan

Table 2 Eigenvalues and contribution rate of *R*

Factors	Eigenvalues	Contribution rate // %	Cumulative contribution rate // %
F_1	22.14	67.08	67.08
F_2	10.86	32.92	100.00

Table 3 Principal factor loading matrix

Indicators	Components 1	Components 2	Indicators	Components 1	Components 2
C_1	−0.96	−0.27	C_{18}	0.54	0.84
C_2	−0.78	0.63	C_{19}	0.93	−0.38
C_3	0.90	−0.43	C_{20}	0.42	−0.91
C_4	−0.95	−0.30	C_{21}	0.66	0.75
C_5	0.25	0.97	C_{22}	0.99	−0.13
C_6	−0.98	−0.19	C_{23}	0.98	0.20
C_7	0.99	0.10	C_{24}	−0.53	0.85
C_8	−0.96	−0.28	C_{25}	0.98	−0.19
C_9	−0.67	−0.74	C_{26}	0.97	−0.23
C_{10}	−0.71	−0.71	C_{27}	0.90	−0.43
C_{11}	−1.00	0.01	C_{28}	0.90	0.44
C_{12}	0.86	0.52	C_{29}	0.92	−0.40
C_{13}	0.17	0.99	C_{30}	0.95	0.32
C_{14}	−0.62	−0.78	C_{31}	0.90	−0.43
C_{15}	−0.36	0.93	C_{32}	0.95	−0.32
C_{16}	−0.99	0.11	C_{33}	0.79	−0.61
C_{17}	−0.35	0.94			

4.1.3 Calculation of Beijing-Tianjin-Hebei industrial competitiveness score. Firstly, the total factor score is $F = 67.08\% F_1 + 32.92\% F_2$; secondly, the weight of each factor (C_1) is calculated; finally, the normalized value is multiplied by the weight to get the score of Beijing-Tianjin-Hebei industrial structure competitiveness, agricultural competitiveness, industrial competitiveness, service industry competitiveness, and high-tech industry competitiveness. It is calculated as follows:

$F_{\text{industrial structure competitiveness}} = 3.75C_1 - 0.43C_2 + 1.45C_3$;

$F_{\text{agricultural competitiveness}} = -3.81C_4 + 3.7C_5 - 3.56C_6 + 3.33C_7 - 3.77C_8 - 4.28C_9 - 4.29C_{10}$;

$F_{\text{industrial competitiveness}} = -3.01C_{11} + 4.16C_{12} + 3.5C_{13} - 4.26C_{14} + 1.75C_{15} - 2.69C_{16} + 1.77C_{11} + 4.19 + 1.67C_{19}$;

$F_{\text{service industry competitiveness}} = -1.46C_{20} + 4.28C_{21} + 2.63C_{22} + 3.58C_{23} + 0.95C_{24} + 2.41C_{25} + 2.24C_{26}$;

$F_{\text{high-tech industry competitiveness}} = 1.44C_{27} + 4.05C_{28} + 1.58C_{29} + 3.84C_{30} + 1.43C_{31} + 1.89C_{32} + 0.57C_{33}$.

The results are shown in Table 4.

Table 4 Beijing-Tianjin-Hebei industrial competitiveness score

Regions	$F_{\text{industrial structure competitiveness}}$	$F_{\text{agricultural competitiveness}}$	$F_{\text{industrial competitiveness}}$	$F_{\text{service industry competitiveness}}$	$F_{\text{high-tech industry competitiveness}}$
Beijing	4.41	7.92	1.52	6.94	11.54
Tianjin	1.40	19.68	20.31	8.32	3.41
Hebei	−5.81	−27.60	−21.83	−15.26	−14.95

4.2 Comparative analysis of Beijing-Tianjin-Hebei industrial competitiveness

4.2.1 Overall comparison. As shown in Fig. 1, the overall industrial competitiveness of Beijing and Tianjin is much higher than that of Hebei, and it can be found that Hebei is a short board in the Beijing-Tianjin-Hebei integration. Therefore, to achieve the coordinated Beijing-Tianjin-Hebei development, it is necessary to further develop the economy of Hebei Province, and enhance the industrial competitiveness of Hebei. In terms of industrial structure competitiveness and high-tech industry competitiveness, Beijing is better than Tianjin; in terms of agricultural competitiveness and industrial competitiveness, Tianjin is better than Beijing; in terms of service industry competitiveness, Tianjin is slightly better than Beijing.

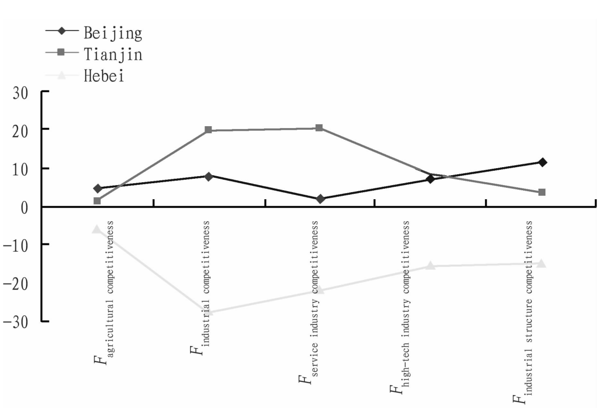

Fig. 1 Overall comparison of Beijing-Tianjin-Hebei industrial competitiveness

4.2.2 Comparison of industrial structure competitiveness. It can be derived from Table 4 that in terms of industrial structure competitiveness, Beijing has a score of 4.41; Tianjin has a score of 1.4; Hebei has a score of −5.81. Overall, Beijing has had the structure dominated by tertiary industry, followed by secondary industry and primary industry, while the structure is dominated by secondary industry, followed by tertiary industry primary industry for Tianjin and Hebei[18]. In the long run, the Beijing-Tianjin-Hebei area is moving towards integration, the industrial structure of the three regions will be further optimized, and the industrial structure competitiveness gap will become increasingly small.

4.2.3 Comparison of agricultural competitiveness. As can be seen from Table 4, in terms of agricultural competitiveness, Beijing has a score of 7.92; Tianjin has a score of 19.68; Hebei has a score of −27.6. It is in the order of Tianjin > Beijing > Hebei, and there is a big gap among the three regions. Taking into account the Beijing-Tianjin-Hebei integration and coordinated development, Hebei is more suitable for the development of agriculture than Tianjin and Beijing. In recent years, the agricultural production capacity in Hebei Province has been constantly enhanced and the agricultural economic structure has been further optimized, making Hebei have more competitive advantages in the development of agricultural industry.

4.2.4 Comparison of industrial competitiveness. According to Table 4, we can see that in terms of industrial competitiveness, Beijing has a score of 1.52; Tianjin has a score of 20.31; Hebei has a score of −21.83. It is in the order of Tianjin > Beijing >

Hebei, and Tianjin is far ahead of Beijing and Hebei. In Hebei, the industrial base is weak in some areas, and the lack of capital and technological innovation ability leads to low level of industrial development in Hebei. Beijing is the country's political and cultural center, and its economic function is further weakened. Therefore, Tianjin is more suitable for the development of industry than Beijing and Hebei.

4.2.5 Comparison of service industry competitiveness. As can be seen from Table 4, in terms of service industry competitiveness, Beijing has a score of 6.94; Tianjin has a score of 8.32; Hebei has a score of −15.26. It is in the order of Tianjin > Beijing > Hebei, and the score of Tianjin and Beijing is much higher than that of Hebei, while there is small difference in score between Tianjin and Beijing. Therefore, Tianjin and Beijing have more advantages than Hebei in developing the service industry. At the same time, from the principal factor extraction and analysis, it is found that the Beijing-Tianjin-Hebei industrial competitiveness hinges in a large measure on service industry competitiveness, and service industry has become the main industry to provide jobs, and pillar industry for industrial structure optimization and economic growth[19]. Therefore, Beijing, Tianjin and Hebei need to vigorously develop the local service industry.

4.2.6 Comparison of high-tech industry competitiveness. We can see from Table 4 that in terms of high-tech industry competitiveness, Beijing has a score of 11.54; Tianjin has a score of 3.41; Hebei has a score of −14.95. It is in the order of Beijing > Tianjin > Hebei, and Beijing is far ahead. This also shows that Beijing has a unique advantage in the development of high-tech industries, more suitable for the development of high-tech industries. High-tech industry has become an important engine of Beijing's economic development.

5 Conclusions and policy recommendations

5.1 Conclusions With the industrial competitiveness in the Beijing-Tianjin-Hebei area in 2013 as the object of study, this paper uses principal component analysis to evaluate and compare the industrial competitiveness in the Beijing-Tianjin-Hebei area, in order to provide reference for Beijing-Tianjin-Hebei joint development. The results show that in terms of industrial structure competitiveness, Beijing > Tianjin > Hebei; in terms of agricultural competitiveness, Tianjin > Beijing > Hebei; in terms of industrial competitiveness, Tianjin > Beijing > Hebei; in terms of service industry competitiveness, Tianjin > Beijing > Hebei; in terms of high-tech industry competitiveness, Beijing > Tianjin > Hebei.

5.2 Policy recommendations (i) In terms of industrial structure competitiveness, it is particularly important to optimize the industrial structure, and improve the industrial structure competitiveness for Beijing, Tianjin and Hebei. (ii) In terms of agricultural competitiveness, Tianjin is better than Beijing and Hebei, but Hebei is more suitable for the development of agricultural industry. In the development of the province's agricultural industry, Hebei government should further adjust the agricultural layout, develop efficient ecological agriculture, and use the advantages of location close to Beijing and Tianjin to develop suburban modern agriculture. (iii) In terms of industrial competitiveness, Tianjin is better than Beijing and Hebei, and Tianjin is more suitable for the development of regional industry. Tianjin government should undertake the transfer of Beijing's industries, optimize the region's electronic information and advanced manufacturing, and construct new research and development platform. (iv) In terms of service industry competitiveness, Tianjin is better than Beijing and Hebei, but Beijing, Tianjin and Hebei all need to further develop the service industry in the region. The Beijing-Tianjin-Hebei area should actively adjust the structure of service industry, and promote the development of modern service industry represented by financial industry, business service industry, cultural sports and entertainment industry, and real estate industry. (v) In terms of Beijing-Tianjin-Hebei integration, the state should strengthen Beijing's financial management, Tianjin's innovative financial operation and Hebei's financial background services. (vi) In terms of high-tech industry competitiveness, Beijing is better than Tianjin and Hebei, so Beijing has more advantages in the development of high-tech industries. Beijing should further improve industrial support policy system, accelerate the upgrading of traditional high-tech industries, and nurture and develop strategic emerging industries.

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search project funding. The legal person of unit assumes the leadership responsibility on scientific research funding management of the whole unit; the management departments of institute bear the responsibility of oversight and management; the research labs are responsible for the scrutiny and supervision on the scientific research funding use in the labs; the project leader is directly responsible for scientific research funding use, and bears legal liability on the reasonableness and authenticity of funding use; the financial management departments are responsible for financial management of research funding, accounting, assisting project leaders in project budgeting, and guiding project leaders to use scientific research funding according to the project task document or agreement, as well as relevant financial regulations; the asset management departments are responsible for the asset management stemming from scientific research funding; the commission for discipline inspection is responsible for supervision and management on the use of scientific research funding; the scientific research management departments assist with research funding management, auditing and supervision.

3.2 Making reasonable funding budget for scientific research project The financial and scientific research management departments should assist project leaders in scientifically, reasonably and truly making scientific research funding budget according to the characteristics and actual needs of research activities, the principles of policy compliance, economic rationality and objective relevance, and the requirements of project establishment unit. For the project involving government procurement, it is necessary to make government procurement budget in strict accordance with the relevant provisions of government procurement. For the key scientific research projects applying for financial support, it is necessary to organize the relevant functional departments, consultants or agencies to participate in budget review, and propose recommendations. The scientific research project funding budget includes all kinds of direct and indirect expenses in the course of project research, so it is necessary to make budget according to expenditure items and different sources of funds, and elaborate the main purposes and measuring basis of expenditure. The budget must be in accordance with the provisions of the funding authority or the fund provider. The direct funding budget is made by project applicants according to the characteristics of scientific research and the actual needs; the indirect funding budget is made according to the prescribed proportion or quota.

3.3 Strictly managing scientific research project expenditure

Research funding must be earmarked, and follow the principle of basing expenditure upon income. It is necessary to ensure that the scientific research funding is used for research projects and related research activities, in strict accordance with project management approach, or approved project budget, expenditure scope and standards. There is also a need to develop the relevant management system, to specify each expenditure item and determine the items that can not be listed in the content.

3.4 Strengthening supervision and inspection The unit should establish discipline inspection group responsible for supervising the use of research project funds, studying and proposing solutions to major issues in the process of supervision, and coordinating investigation on violations of discipline in the use of scientific research project funding.

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