A Study on the Development Level of the Cultural and Creative Industries in Eastern China Based on Principal Component Analysis

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Abstract. With the growing demands of building China into a cultural powerhouse and the increasingly diverse needs of its people, an increasing number of cities are placing greater emphasis on the development of the cultural and creative industries. This study focuses on the eastern regions of China, where the cultural and creative industries exhibit relatively advanced development. It analyses disparities in industrial development across ten eastern provinces, employing principal component analysis to evaluate the development levels of cultural and creative industries in these ten provinces and municipalities. Ultimately, the ten provinces are categorised into three tiers based on their development levels: strong, moderate, and weak. Recommendations are proposed for regions exhibiting weaker development in this sector.

Keywords: cultural and creative industries; principal component analysis; cluster analysis

1 Introduction

With economic globalisation and rising living standards, culture plays an increasingly pivotal role in society. Since General Secretary Jinping Xi proposed the "new quality productive forces" concept in September 2023, technological progress, talent development, and digitalisation have driven the cultural industry's transformation, spurring rapid growth in cultural and creative industries (CCI). CCIs enrich public cultural engagement via products like books, audio-visual content, and AR interactions, while boosting economic development and fostering innovation. However, the sector faces imbalances: inadequate resource allocation, policy support gaps, and talent shortages in some regions.

Driven by the internet, the cultural industry has gained renewed vitality, attracting increasing attention from domestic scholars. Peter Campbell [5]presents a new critical engagement with the concept of Cultural and Creative Industries (CCIs).G. Cicerone[6] estimates an entry model analysing the ability of Italian provinces to successfully create new sectoral specializations.Macroscopically, Xiang Yong [1] emphasizes a holistic approach to digital cultural industry development, urging reflection on potential risks,Jiaqi Zhang[2] identified an east-west spatial differentiation in China's cultural

S. Garcia-Esteban et al. (eds.), *Proceedings of the 2026 5th International Conference on Social Sciences and Humanities and Arts (SSHA 2026)*, Advances in Social Science, Education and Humanities Research 1014,
https://doi.org/10.2991/978-2-38476-577-5_139

industry via a three-stage DEA model (2015-2021). Microscopically,Juan Huang [3] highlights priorities like green technology, talent cultivation, and IP protection, while some studies focus on specific provinces/cities. However, few quantitative analyses exist on eastern China's cultural industry drivers.Giusy Sicaoffers a comprehensive framework that positions CCIs at the core of a broader economic, territorial, managerial, and political context.

Under the new development paradigm, cultural and creative industries (CCI) thrive through digital storytelling, cultural IP, and digital tourism , meeting public demands and preserving cultural heritage. As a key force for urban transformation and soft power competition, CCIs revitalize sunrise sectors and grow steadily in major cities . Eastern China's rich cultural resources and advanced economy make CCI development a strategic priority. This study uses principal component analysis to evaluate 10 eastern provinces, constructing an index system based on Li Mingyu [4], covering four primary indicators: industry personnel, government support, consumer demand, related enterprises, and cultural facility infrastructure.

2 Analysis of Disparities in the Development of the Cultural and Creative Industries Across Eastern Provinces of China

2.1 Indicator System for the Development Level of the Cultural and Creative Industries in Eastern Provinces

Principal Component Analysis (PCA) is a statistical method that employs orthogonal transformation to convert a set of variables, which may exhibit inertia, into a set of mutually independent variables. This transformed set of variables is termed principal components. Through the concept of dimensionality reduction, principal components transform multiple indicators into a small number of composite indicators. Each principal component reflects the primary information of the original variables without duplicating the information contained within others. Its core principle involves identifying new feature dimensions using the eigenvalues and eigenvectors of the covariance or correlation matrix, ensuring these dimensions maximally preserve the information from the original data.

Building upon existing relevant research and drawing upon the historical and cultural context and developmental circumstances of China's eastern regions, an evaluation framework for the cultural apparel industry across ten provinces has been established. This framework encompasses five dimensions: perspectives of cultural and related industry personnel, governmental support, consumer demand, relevant enterprises, and the foundational infrastructure of cultural facilities, as illustrated in Table 1:

Table 1. Cultural and Creative Industries Analysis Indicator System for Ten Provinces.

Overall Indicator	Primary Indicator	Secondary Indicator	Indicator Attribute
Level of Development of the Cultural and Creative Industries in Each Province	Perspective of Employees in Cultural and Related Industries	Number of employees in cultural and related industries at year-end (persons)	+
		Number of R&D personnel in cultural and related industries (persons)	+
		Number of employees in above-quota cultural, related industries and retail enterprises at year-end (persons)	+
	Government Support	General public budget expenditure on culture, tourism, sports and media (¥ billion)	+
		Fiscal allocation for cultural relics protection and management institutions (¥ ten thousand)	+
	Consumer Demand Perspective	Per capita cultural and entertainment expenditure (¥)	+
		Audience attendance at artistic performances in venues (ten thousand persons)	+
	Related Enterprises Perspective	Service revenue of cultural and related industries above designated size (ten thousand yuan)	+
		Operating revenue of cultural and related industries enterprises above designated size (ten thousand yuan)	+
		Total assets of wholesale and retail enterprises in cultural and related industries above designated size (ten thousand yuan)	+
		Total assets and liabilities of administrative and public institutions in broadcasting and television (ten thousand yuan)	-
	Related Cultural Facilities Infrastructure	Total revenue of museums (ten thousand yuan)	+
		Total assets of cultural relics protection and management institutions (ten thousand yuan)	+

2.2 Analysis of the Development Level of the Cultural and Creative Industries in Eastern Provinces

This study uses SPSS 27.0 to analyze the 2022 cultural and creative industry (CCI) levels of ten eastern Chinese provinces/municipalities: Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. Data is sourced from the 2023 Statistical Yearbook of China's Cultural and Related Industries, covering key indicators such as per capita cultural expenditure, government cultural-related budget, industry employment, enterprise revenue, artistic performance attendance, R&D personnel, cultural facility assets, and cultural relics protection funding. Due to inconsistent measurement units across indicators, data standardisation was conducted to ensure objective evaluation results.

Subsequently, principal component analysis was conducted on the standardised indicator data using SPSS software, identifying three factors with eigenvalues exceeding 1. Their respective contribution rates were: 61.664, 13.929, and 11.043.

In Table 2, the indicators of the first principal component demonstrated significant correlation with talent development within the cultural and creative industries across the ten provinces and municipalities, as well as the revenue performance of relevant

enterprises and institutions. Consequently, the first principal component was defined as economic and industrial conditions. The indicators of the second principal component showed strong correlations with residents' cultural consumption and the cultural services sector within the cultural and creative industries. Consequently, this component was defined as “Cultural Demand Conditions”. The indicators of the third principal component demonstrated significant correlations with aspects such as cultural relics conservation management and artistic dissemination. Thus, this component was defined as “Resource Innovation Conditions”.

Table 2. Load matrix.

Indicator	Principal Component 1	Principal Component 2	Principal Component 3
Per capita expenditure on cultural and recreational activities (RMB)	0.098	0.92	0.145
General public budget expenditure on culture, tourism, sports and media (RMB billion)	0.862	0.31	0.303
Year-end employees in above-designated-size cultural and related industries (persons)	0.966	0.213	-0.02
Operating revenue of above-designated-size cultural and related industries enterprises (RMB ten thousand)	0.743	0.631	0.067
Audience attendance at artistic performances in venues (RMB ten thousand)	0.224	0.451	0.669
R&D personnel in above-designated-size cultural and related industries enterprises (persons)	0.965	0.212	0.002
Number of employees at year-end in above-quota cultural and related industries and retail enterprises (persons)	0.934	0.324	-0.004
Total assets of above-quota cultural and related industries wholesale and retail enterprises (10,000 yuan)	0.683	0.61	0.116
Operating revenue of above-quota cultural and related industries service enterprises (10,000 yuan)	0.313	0.843	0.074
Total museum revenue (10,000 yuan)	0.707	0.563	0.366
Total assets of cultural relics protection and management institutions (10,000 yuan)	0.018	0.126	0.935
Fiscal allocations to cultural relics protection and management institutions (10,000 yuan)	0.077	-0.033	0.91
Total assets and liabilities of radio and television administrative institutions (10,000 yuan)	-0.933	0.037	-0.208

Employing the regression coefficient method, the score coefficient Fi is calculated, and the scores for the three principal factors across provinces and municipalities are determined. The weighting of each factor is calculated using the variance contribution ratio of each factor relative to the total variance contribution ratio of the three factors as

the weighting factor. Wi yields the comprehensive evaluation model for the cultural and creative industries, as shown in Formula (1):

$$S = \sum_{i=1}^{3} F_i * W_i \tag{1}$$

Here, S denotes the composite score for the level of cultural and creative industry development. A higher S value calculated using this formula indicates a more advanced level of cultural and creative industry development in the region. The composite score rankings for the ten eastern provinces are presented in Table 3:

Table 3. Ranking of Factor Scores and Total Scores for 10 Eastern Provinces and Municipalities.

Province	Principal Component 1 Score	Principal Component 2 Score	Principal Component 3 Score	Composite Score	Ranking
Beijing	2.958383435	3.700715862	1.025634283	2.860471846	4
Tianjin	-0.566554985	0.846911713	-0.011986939	-0.2312804	9
Hebei	-0.105786312	0.500386947	0.619865174	0.09809691	8
Shanghai	2.438595484	3.410662847	1.16080535	2.464762336	5
Jiangsu	4.906489427	3.27207924	1.480671551	4.175753597	2
Zhejiang	3.566580586	3.657608096	3.252187075	3.545039656	3
Fujian	0.745971851	1.314908871	0.222525948	0.788935858	7
Shandong	2.005089537	1.964735707	1.392060664	1.921944062	6
Guangdong	5.866125766	3.811935385	1.082351627	4.888810772	1
Hainan	-0.843062831	0.133264709	-0.171347891	-0.575915736	10

The results indicate that among the ten eastern provinces, the top five in overall scores are Guangdong, Jiangsu, Zhejiang, Beijing and Shanghai, while the bottom three are Tianjin, Hebei and Hainan.

2.3 Cluster Analysis

In this analytical section, the author defines R samples and P metrics, establishing both inter-sample and inter-class distances. Each of the R samples is treated as a distinct class, whereby inter-sample clustering and inter-class distances are identical. The two classes exhibiting the smallest inter-class distances are then merged into a new class. Subsequently, the distance between the new class and the remaining classes is calculated. The two classes with the smallest inter-class distances are then merged, and this process is repeated. Ultimately, a single large class encompassing all samples is obtained, completing the system clustering.

The system cluster analysis process was completed using SPSS software. Employing the average linkage method between groups and employing squared distance as the metric, the resulting system cluster analysis diagram is presented in Table 4:

Table 4. Clustering analysis results.

Classification	Province
Category I (Well-developed)	Jiangsu, Zhejiang, Guangdong
Category Two (General Development)	Beijing, Shanghai, Shandong
Category III (Less Developed)	Tianjin, Hebei, Fujian

SPSS-based cluster analysis (inter-group mean linkage method, squared distance metric) categorized ten eastern provinces/municipalities into three tiers. Guangdong, Jiangsu, and Zhejiang (composite scores 3.5–5.0) form the strong-development tier, benefiting from Guangdong's robust economic foundation, and Jiangsu/Zhejiang's coastal geographical advantages, rich cultural resources, and high fiscal investment in museums and heritage protection. Beijing, Shanghai, and Shandong (scores 1.5–3.0) constitute the moderate tier. Tianjin, Hebei, Fujian, and Hainan (scores <1.0) are the weak tier, with notable gaps from the top two.

A striking inverse correlation emerges between overall CCI rankings and broadcasting/television institutions' assets and liabilities: Jiangsu (top tier) has the highest, while Hainan (bottom tier) has the lowest. Tianjin and Hebei, in the Capital Economic Circle with profound cultural heritage, rank poorly in cultural-related public budget, artistic performances, and service industry revenue, indicating insufficient support for CCIs—though Tianjin's high per capita cultural expenditure signals unmet market demand and growth potential. Hainan, the weakest performer across multiple indicators, lacks effective integration between CCIs and local tourism; future development should focus on infrastructure improvement, investment promotion, and leveraging its ecological advantages.

3 Conclusions and Recommendations

3.1 Conclusions

This study evaluates the cultural and creative industry (CCI) development of ten eastern Chinese provinces/municipalities using data from the China Cultural and Related Industries Statistical Yearbook and 14 key indicators. Principal Component Analysis (PCA) for dimensionality reduction and SPSS-based cluster analysis (squared distance metric) categorized the regions into three tiers: Guangdong, Jiangsu, and Zhejiang (strong development, backed by solid economic foundations, cultural resources, and policy support); Beijing, Shanghai, and Shandong; and Tianjin, Hebei, Fujian, and Hainan (weak). Significant inter-provincial disparities stem from factors like cultural consumption attitudes, historical contexts, industrial systems, and inadequate policy/talent support in weaker regions. Narrowing the gap requires tailored policies, local adaptation, and high-calibre talent attraction.

3.2 Recommendations

Key recommendations include: 1) Cultivating competitive CCI brands by integrating local culture with new quality productive forces, leveraging technology (e.g., Jingde-

zhen's heritage transformation, Chayanyueshuai's cultural product expansion); 2) Diversifying products to meet personalized/digital demands; 3) Rationalizing historical-cultural resource use (learning from Nanjing's "Smart Confucius Temple" and enhancing technology-culture integration); 4) Embracing sustainability via recyclable materials and industry-academia-research innovation systems ; 5) Establishing robust policy support (following Shenzhen's fiscal investment and IP protection model) to foster innovation and guide urban transformation for heavy industry-dependent cities.

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