



# Analysis of the Spatial Heterogeneity of China's Sports Cultural Industry Investment Based on Panel Data

Kunpeng Li

Department of Physical Education, Zhejiang Yuexiu University, Shaoxing, China  
Email: 20131050@zyufl.edu.cn

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## Abstract

This paper analyzes the spatial heterogeneity of China's sports cultural industry investment using panel data from 31 provinces, municipalities, and autonomous regions from 2013 to 2021. Exploratory spatial data analysis (ESDA) and spatial econometric models are employed to investigate the spatial dependence and influencing factors of sports cultural industry investment. The results show that the investment in China's sports cultural industry has significant regional differences, with the eastern coastal provinces having much higher investment levels than the central and western regions. The investment in each province exhibits positive spatial correlation and significant spatial agglomeration effects. High-level investment regions are concentrated in contiguous areas, while low-level investment regions are distributed in adjacent areas, indicating spatial dependence and spillover effects in the development of the sports cultural industry among regions. The main factors influencing the investment level include gross regional product, general public budget expenditure, and total expenditure on culture, sports, and media. Provinces with developed economies, strong government support, and a good foundation for the cultural industry have higher investment levels in the sports cultural industry. The study suggests that the state should increase policy support and capital investment in underdeveloped areas, promote industrial cooperation among regions, and optimize resource allocation. Local governments should formulate targeted policies, improve infrastructure, standardize statistical indicators, explore local characteristic resources, cultivate regional brand events, and promote the integration of sports culture with other industries to expand the industrial development space.

## Subject Areas

Sociology

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## Keywords

China, Panel Data, Sports Culture Industry, Spatial Econometrics

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### 1. Introduction

Culture is the soul of a nation, embodying its vitality and creativity, and is the spiritual bond that maintains national unity and ethnic solidarity. To achieve the great rejuvenation of the Chinese nation, it is necessary to rapidly establish cultural advantages [1]. With the significant development and prosperity of socialist culture, the sports cultural industry has emerged like bamboo shoots after a spring rain. As an emerging sunrise industry in China, its development has been rapid. In 2014, the State Council issued the “Several Opinions on Accelerating the Development of the Sports Industry and Promoting Sports Consumption.” The document proposed that based on the overall situation and taking all factors into consideration, the comprehensive development of various categories and forms of the sports industry should be promoted, and the integration of the sports industry with other industries should be encouraged to achieve coordinated development between the sports industry and the economy and society. First, as an essential component of the sports industry, the sports cultural industry plays an increasingly important role that other sports industries cannot replace. Second, the sports cultural industry not only meets the growing demand for sports culture among the people but also enhances their quality of life and overall quality, contributing to the construction of a harmonious society. Finally, the sports cultural industry plays a crucial role in expanding emerging markets, increasing domestic demand, promoting industrial development, and boosting economic growth, serving as a vital engine for the development of the national cultural industry.

At present, there are two distinctly different perspectives on the development of China’s cultural industry: content-based integration and spatial-based integration. The latter mainly refers to the spatial agglomeration effect of the cultural industry under the premise of the non-steady development of China’s regional economy [2]. Led by the cultural industry, the development of the sports cultural industry should also follow this law, that is, the investment in the sports cultural industry has spatial autocorrelation. It is not only affected by the investment intensity of the region itself, but the investment level of the sports cultural industry in neighboring regions will also have a certain spillover effect on the region [3]. Therefore, this study adopts a spatio-temporal research paradigm and demonstrates its innovativeness in four aspects: research perspective, methodology, conclusions, and implications. In terms of research perspective, this paper utilizes provincial panel data to systematically analyze the regional differences in China’s sports culture industry investment from both temporal and spatial dimensions, revealing its spatio-temporal evolution patterns at a macro level. Re-

garding research methodology, the study comprehensively employs exploratory spatial data analysis and spatial econometric models, combining qualitative and quantitative approaches, as well as temporal and spatial dimensions, to explore the spatial dependency, agglomeration characteristics, and influencing mechanisms of sports culture industry investment from multiple angles. In terms of research conclusions, the study empirically reveals the spatial pattern evolution trends and key turning points of sports culture industry investment, and analyzes the spatial spillover effects of factors such as regional GDP, fiscal expenditure, and cultural industry foundation from a spatial econometric perspective. Finally, this paper puts forward policy recommendations for promoting coordinated regional development, such as increasing support for less developed regions, leveraging agglomeration effects, and formulating policies based on local conditions, providing new ideas for optimizing the spatial layout of the industry. In summary, this research adopts a novel perspective and methodology to reveal the spatio-temporal evolution patterns and influencing mechanisms of sports culture industry investment, which has significant theoretical and practical value for promoting coordinated regional development.

## 2. Literature Review

Research on China's sports cultural industry by Chinese scholars started relatively late, gradually developing in the 1990s. With the development of social culture, the relevant research results have become rich, and research perspectives have diversified. After reading and organizing the relevant literature, Chinese scholars' research perspectives mainly focus on the following aspects:

First, from the perspective of geographical space, Fu Taishan [4] analyzed the structural characteristics of the development of the sports cultural industry in Shandong Province and found that there was a regional spatial layout imbalance in the sports cultural industry in Shandong Province, with a clear dual structure. Wang Xiaolin *et al.* [5] explored the competitiveness of the sports cultural industry and pointed out that the competitiveness level of China's sports cultural industry shows obvious regional differences. They used cluster analysis to divide the sports cultural industry into three categories according to the strength of competitiveness. Zhang Deli *et al.* [6] studied the sustainable development of the regional sports cultural industry, proposing a view oriented by regional geographical environment and cultural resources, and further believed that the agglomeration of geographical resources and cultural identity are strategic choices for the sustainable development of the sports cultural industry.

Second, from the perspective of economics, Zhou Ying *et al.* [7] discussed the regional competitiveness of the sports cultural industry through economic indicators such as economic strength, degree of internationalization, and sports cultural consumption, and scientifically constructed the development pattern of the sports cultural industry. Lei Lei *et al.* [2] explored the spatial agglomeration of sports cultural industry investment, and the research showed that there is spatial non-stationarity in China's provincial sports cultural industry investment, and

the sports cultural industry has agglomeration, correlation, and spillover effects in space. Yao Jiejing *et al.* [8] used economic indicators such as industrial efficiency and cost control to construct a competitiveness evaluation system for China's sports cultural industry. The results showed that the competitiveness level of China's sports cultural industry has significant regional differences, showing a trend of "high in the east and low in the west," and divided China's sports cultural industry into three groups from the perspective of cluster analysis.

Third, from the perspective of cultural integration, Zhao Xiaolin *et al.* [9] and Ren Tangke *et al.* [10] proposed the view of the integration of network communication media and the sports cultural industry, using the communication power of traditional media and new media to expand the development space of the sports cultural industry and form the characteristics of the sports cultural industry in the new era. Kang Li *et al.* [11] conducted a comprehensive analysis of the sports cultural industry in the post-Olympic period, using the SWOT analysis method to summarize the advantages and disadvantages of the development of the domestic sports cultural industry and formulated four development strategies. Zhong Haiping *et al.* [12] proposed the view of combining the development of the ethnic traditional sports cultural industry with spiritual civilization and formulated a model of integrated development and countermeasures for sustainable development.

In summary, scholars have conducted diversified analyses of the sports cultural industry from different perspectives, with fruitful results, providing a large number of reference bases for this study. However, overall, the current research mainly focuses on qualitative research, reflecting some phenomena and regional differences in the development of the sports cultural industry, and has not systematically studied the time and spatial dimensions of sports industry investment. Therefore, compared with previous studies, this study has the following innovations: First, provincial panel data are used to visualize the regional differences in China's sports industry investment from the time and space dimensions at the macro level. Second, through exploratory spatial data analysis (ESDA), the spatial dependence of provincial panel data is explored, and the agglomeration and dispersion characteristics of global and local autocorrelation are analyzed. Finally, based on the general linear model, considering the influence of spatial factors, a spatial econometric model is constructed to select the spatial effects of economic, social, and demographic factors on the investment in the sports cultural industry.

### 3. Data Sources

This study takes China's 31 provinces as the research area (due to data availability, data from Hong Kong, Macao, and Taiwan are not included) and selects the amount of investment in the sports cultural industry in provinces, municipalities, and autonomous regions from 2013 to 2021 as the measurement index of sports cultural industry investment in each region. To ensure the reliability of the research data, all data resources are from the "China Cultural Related Industry Statistical Yearbook," "China Urban Statistical Yearbook", and "China Statistical Yearbook," and spatial econometric models are used to process the relevant data.

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## 4. Research Methods

### 4.1. Exploratory Spatial Data Analysis

Exploratory spatial data analysis (ESDA) is a special quantitative method for spatial data analysis, mainly used to describe spatial distribution, identify spatial outliers, and determine spatial association patterns [13]. Global spatial autocorrelation and local spatial autocorrelation are two spatial data methods used to measure and test spatial distribution patterns. When using GeoDa for autocorrelation diagnosis, a spatial weight matrix must be constructed.

### 4.2. Spatial Econometric Models

The spatial effects of spatial econometrics include spatial autocorrelation and spatial heterogeneity, mainly dealing with the spatial interaction effects between spatial units. The investment in the sports cultural industry is constrained by multiple factors. Based on the previous research of scholars, this study constructs evaluation indicators and conducts regression analysis on the dependent and independent variables. As this study incorporates spatial influence factors, it adopts spatial autoregressive models, mainly including the spatial lag model (SLM) and the spatial error model (SEM).

#### 4.2.1. Spatial Error Model

The spatial error model (SEM) describes the spatial disturbance correlation and spatial overall correlation [13].

Its economic meaning is that a shock occurring in one region will be transmitted to neighboring regions through the special covariance structure form  $W$ , and this transmission form has a long time persistence and is decaying, that is, the spatial impact has a higher-order effect.

#### 4.2.2. Spatial Lag Model

The spatial lag model (SLM) describes the spatial substantive correlation, that is, the characteristics of a regional unit are not only affected by its own attributes but also by the influence of neighboring units [14].

Its economic meaning is that if the variable of interest has spatial correlation, merely considering its own explanatory variable  $X$  is insufficient to well estimate and predict the changing trend of the variable; while considering the appropriate impact caused by the spatial structure in the model can better control the influence caused by this spatial effect.

## 5. Results and Analysis

### 5.1. Global Spatial Autocorrelation Measurement

Using GeoDa software, a geographic proximity spatial weight matrix is constructed using the QUEEN first-order method, and the Moran index of the investment value of the sports cultural industry in various provinces, municipalities, and autonomous regions in China from 2013 to 2021 is calculated. The results are shown in **Table 1**.

**Table 1** shows that from 2013 to 2021, the Moran's I index of the sports culture industry investment in 31 provincial-level regions in China is positive, indicating that the investment in China's sports culture industry has a significant spatial positive correlation, presenting high-value or low-value clustering. As time goes by, the clustering trend shows an inverted U-shape, with an overall trend of strong to weak spatial correlation. From 2013 to 2014, the spatial positive correlation increased and became more significant. The Moran's I index rose from 0.1011 to 0.1841, indicating an increase in spatial positive correlation. At the same time, the P-value decreased from 0.092 to 0.031, lower than the 0.05 significance level, indicating that the spatial autocorrelation was more statistically significant. From 2014 to 2016, the spatial positive correlation weakened, and the significance decreased. The Moran's I index dropped from 0.1841 to 0.1081, indicating a weakening of spatial positive correlation. The P-value increased from 0.031 to 0.110, higher than the 0.05 significance level, indicating a decrease in the statistical significance of spatial autocorrelation. From 2016 to 2018, the spatial positive correlation strengthened again and became significant. The Moran's I index increased from 0.1081 to 0.1734, indicating a restrengthening of spatial positive correlation. The P-value decreased from 0.110 to 0.018, lower than the 0.05 significance level, indicating that the spatial autocorrelation became statistically significant again. From 2018 to 2021, the spatial positive correlation continued to weaken, and the significance also declined. The Moran's I index decreased year by year from 0.1734 to 0.0331, indicating a continuous weakening of spatial positive correlation, and the correlation was very weak by 2021. The P-value increased from 0.018 to 0.226, far higher than the 0.05 significance level, indicating that the statistical significance of spatial autocorrelation was also continuously decreasing. It can be seen that 2014 and 2018 are two key turning points. Before and after these two years, the spatial positive correlation and statistical significance both underwent significant changes, showing a dynamic fluctuation feature of "strengthening-weakening-strengthening-weakening".

**Table 1.** Global Moran index and test of China's sports cultural industry investment from 2013 to 2021.

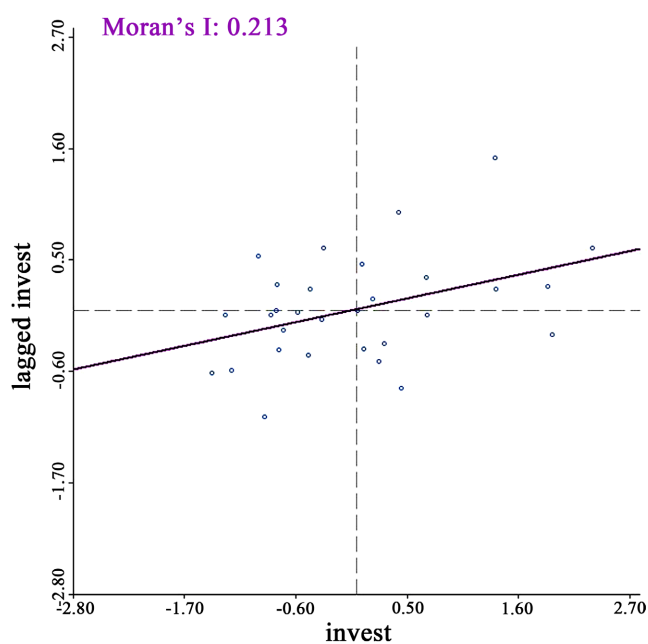
Year	Moran's I	Z-value	P-value
2013	0.1011	1.3412	0.092
2014	0.1841	1.9303	0.031
2015	0.0791	1.2002	0.113
2016	0.1081	1.2310	0.110
2017	0.2125	2.1912	0.020
2018	0.1734	2.3063	0.018
2019	0.1426	1.6438	0.054
2020	0.0499	0.8077	0.190
2021	0.0331	0.6662	0.226

## 5.2. Local Spatial Autocorrelation Measurement

The global Moran's I index is only used to explain whether the investment level of the sports cultural industry has agglomerated, but the spatial correlation relationship, the degree of spatial correlation, and the contribution of spatially correlated individuals to the entire region and other spatial characteristics of the spatial individuals of regional units will be obscured. To further study the agglomeration characteristics of the development of the sports cultural industry within each provincial region, the Moran scatter plot is used to test the spatial correlation within the local scope.

According to the research needs, this paper uses the sports cultural industry investment value in 2017 as cross-sectional data and uses GeoDa software to draw a scatter plot.

**Figure 1** shows a rectangular coordinate system. This coordinate system is divided into four quadrants, namely the first quadrant, the second quadrant, the third quadrant, and the fourth quadrant. Among them, the first quadrant is high-value/high-value (HH), meaning that high observation value spatial units are surrounded by high observation value spatial units; the second quadrant is low-value/high-value (LH), meaning that low observation value spatial units are surrounded by high observation value spatial units; the third quadrant is low-value/low-value (LL), meaning that low observation value spatial units are surrounded by low observation value spatial units; the fourth quadrant is high-value/low-value (HL), meaning that high observation value spatial units are surrounded by low observation value spatial units. The first and third quadrants represent positive spatial correlation of observed values, while the second and fourth quadrants represent negative spatial correlation of observed values. The slope is the Moran's I statistic.



**Figure 1.** Moran scatter plot of China's sports cultural industry investment in 2017.

The regions located in the first quadrant are: Beijing, Guangxi, Hebei, Jiangsu, Shandong, Shanghai, Tianjin, and Zhejiang. These regions show an H-H spatial association pattern, meaning that high-value regions of sports cultural industry investment are surrounded by high-value regions. The regions located in the second quadrant are: Anhui, Fujian, Jilin, Jiangxi, and Chongqing. These regions show an L-H spatial association pattern, meaning that low-value regions of sports cultural industry investment are surrounded by high-value regions. The regions located in the third quadrant are: Gansu, Guizhou, Henan, Heilongjiang, Ningxia, Qinghai, Shanxi, Tibet, Xinjiang, and Yunnan. These regions show an L-L spatial association pattern, meaning that low-value regions of sports cultural industry investment are surrounded by low-value regions. The regions located in the fourth quadrant are: Guangdong, Hubei, Liaoning, Inner Mongolia, Shaanxi, and Sichuan. These regions show an H-L spatial association pattern, meaning that high-value regions of sports cultural industry investment are surrounded by low-value regions.

### 5.3. Constructing Spatial Econometric Models

From the results of the spatial autocorrelation analysis, it can be seen that during 2013-2021, the sports cultural industry investment in various regional units in China has spatial autocorrelation. However, it is still necessary to explore which factors influence the level of sports cultural industry investment, and spatial dependence effects need to be considered. Traditional regression models lack sufficient consideration of spatial effects, so there will be certain errors when using traditional models for calculation, and the results obtained lack scientific and complete explanations. Therefore, this study takes into account the spatial error (SEM) and spatial lag (SLM) in spatial factors to construct new spatial econometric models.

#### 5.3.1. Variable Selection

The investment level of China's sports cultural industry has spatial dependence in certain regional spatial units, with significant spatial agglomeration. This effect is inevitably influenced by other related factors and is organically combined in a certain geographical space, with the typical characteristic being spatial geographic proximity. When studying the investment level of the sports industry, domestic and foreign scholars usually consider economic indicators such as regional economic level, population, disposable income of residents, and sports consumption. However, due to the imperfect sports data statistical system in China and the lack of a systematic sports database, sports-related statistical data are relatively lacking. Therefore, considering the authenticity, accuracy, and availability of data, referring to existing research results, and combining the research content of this paper, the following factors are selected as explanatory variables:

Gross regional product (unit: 100 million yuan) (GDP), regional population (unit: 10,000 people) (RP), per capita consumption expenditure (unit: yuan)



(PCE), per capita disposable income (unit: yuan) (PDI), general public budget expenditure of the region (unit: 100 million yuan) (EXP), general public budget revenue of the region (unit: 100 million yuan) (INC), fixed asset investment of the whole society (unit: 100 million yuan) (FAI), and total expenditure on culture, sports, and media (unit: 100 million yuan) (SCE) of 31 provinces, municipalities, and autonomous regions in China in 2017. The sports cultural industry investment value (unit: 100 million yuan) (SCI) of each regional unit is used as the explained variable. The data are all from the China Statistical Yearbook, China Cultural Related Industry Statistical Yearbook, and China Urban Statistical Yearbook, and the data are true and effective.

### 5.3.2. Model Construction and Testing

Using the sports cultural industry investment value as the explained variable and seven variables such as GDP, regional population, and per capita consumption expenditure as explanatory variables, an ordinary least squares model (OLS) is first established, and the estimation method uses the least squares method. As shown in **Table 2**, the OLS model indicates that the gross regional product and the total expenditure on culture, sports, and media have a significant positive impact on the investment in the sports cultural industry, while the other five variables have no significant impact on the investment in the sports cultural industry. That is, the higher the gross regional product and the higher the total expenditure on culture, sports, and media, the higher the level of investment in the sports cultural industry. However, the ordinary least squares model is the most basic model in classical econometrics and does not include spatial interaction, and does not consider spatial effects. If spatial effects exist, the estimates obtained by the least squares method are biased, so it is necessary to establish spatial econometric models to further examine their spatial effects.

**Table 2** respectively establishes the spatial lag model (SLM) and the spatial error model (SEM). First, the maximum likelihood estimation method is used to select the SLM and SEM models. The optimal explanatory model is selected based on three goodness-of-fit indicators. In **Table 2**, the LogL value, AIC value, and SC value of the SLM model are  $-75.083$ ,  $170.167$ , and  $185.132$ , respectively, and the LogL value, AIC value, and SC value of the SEM model are  $-74.861$ ,  $167.723$ , and  $181.191$ , respectively. Comparing the LogL values, the LogL value of the SEM model is larger than that of the SLM model. Comparing the AIC and SC values, both the AIC and SC values of the SEM model are smaller than those of the SLM model, so the SEM model is better than the SLM model. Second, according to the criterion proposed by Anselin *et al.* **Table 3** discriminates and tests the results of model estimation. The results show that LM (error) is significant while LM (lag) is not significant, so a spatial error model (SEM) is established. Finally, the  $ERR\_Residual$  Moran's I of the SEM model analysis is  $0.002$ , and the P value is  $0.371$ , which is not significant, indicating that there is no heteroscedasticity in the regression residuals of the spatial error regression model, so the SEM model is finally selected for explanation.

**Table 2.** Regression estimation results of factors influencing the investment in the sports cultural industry in China's provincial units in 2017.

Model	OLS				SLM				SEM			
	C	SD	T	P	C	SD	T	P	C	SD	T	P
W_SCI					-0.001	0.127	-0.013	0.989				
CONSTANT	-1.593	1.612	-0.988	0.333	-1.592	1.380	-1.154	0.249	-1.420	1.366	-1.040	0.298
RP	0.000	0.000	0.593	0.559	0.000	0.000	0.689	0.491	0.000	0.000	0.569	0.569
GDP	0.000	0.000	2.354	0.027	0.000	0.000	2.723	0.006	0.000	0.000	2.457	0.014
PCE	0.001	0.001	1.117	0.274	0.001	0.000	1.286	0.198	0.001	0.000	1.317	0.188
EXP	-0.001	0.001	-1.811	0.083	-0.001	0.000	-2.091	0.036	-0.001	0.000	-2.235	0.025
SCE	0.0723	0.023	3.135	0.004	0.072	0.021	3.445	0.001	0.071	0.019	3.755	0.000
FAI	-0.000	0.000	-1.399	0.175	-0.000	0.000	-1.558	0.119	-0.000	0.000	-1.283	0.199
PDI	-0.000	0.000	-0.337	0.739	-0.000	0.000	-0.395	0.693	-0.000	0.000	-0.454	0.649
INC	-0.001	0.001	-0.688	0.498	-0.000	-0.001	-0.793	0.428	-0.000	0.001	-0.392	0.695
LAMBDA									0.201	0.240	0.838	0.402
R <sup>2</sup>	0.902				0.902				0.904			
LogL		-75.083				-75.083					-74.861	
AIC		168.167				170.167					167.723	
SC		181.636				185.132					181.191	

**Table 3.** Discriminant test of SLM model and SEM model estimation.

TEST	MI/DF	TEST VALUE	P
Moran's I (error)	0.172	2.223	0.025
LM (lag)	1	2.213	0.137
Robust LM (lag)	1	2.770	0.096
LM (error)	1	4.611	0.032
Robust LM (error)	1	0.373	0.541

The estimation results of the spatial error model show that there is a positive spatial correlation between the investment in the sports cultural industry in various regional units in China, and the investment in the sports cultural industry in neighboring provinces has obvious regional agglomeration characteristics. Among them, the gross regional product, general public budget expenditure of the region, and total expenditure on culture, sports, and media all passed the significance test, indicating that the gross regional product, general public budget expenditure of the region, and total expenditure on culture, sports, and media

are positively correlated with the investment in the sports cultural industry in each province. It shows that the level of gross regional product has a great impact on the investment in the sports cultural industry, the general public budget expenditure of the region represents the government's support for the tertiary industry, which has a very obvious promoting effect on the development of investment in the sports cultural industry in various provinces in China, and the total expenditure on culture, sports, and media itself belongs to the category of cultural industry, and its level of expenditure has a significant impact on the investment in the sports cultural industry. The general public budget expenditure of the region passed the significance test, and the coefficient is negative, indicating that regions with higher general public budget expenditure have lower cultural investment in the sports industry, and regions with lower general public budget expenditure have higher investment in the sports cultural industry. In other words, in regions with lower public budget expenditure, the cultural industry will occupy a greater proportion, and sports culture is more important for ordinary people. The four variables of regional population, per capita consumption expenditure, per capita disposable income, general public budget revenue of the region, and fixed asset investment of the whole society did not pass the significance test, the coefficients are not obvious, and the four indicators are unbalanced, and there are differences in the research field.

## **6. Conclusion and Suggestions**

### **6.1. Conclusion**

The investment in China's sports cultural industry has obvious regional differences. The investment level in eastern coastal provinces such as Shanghai, Beijing, and Guangdong is far higher than that in the central and western regions, showing a spatial pattern of "high in the east and low in the west". The investment in the sports cultural industry in each province has a positive spatial correlation, showing a significant spatial agglomeration effect. High-level investment regions are concentrated in contiguous areas, and low-level investment regions are also distributed in adjacent areas. This indicates that there are spatial dependence and spillover effects in the development level of the sports cultural industry among regions. The main factors affecting the investment level of the sports cultural industry include the gross regional product, general public budget expenditure of the region, and total expenditure on culture, sports, and media. Provinces with developed economies, strong government support, and a good foundation for the cultural industry have a higher investment level in the sports cultural industry. Factors such as population size, income and consumption level of residents, and fixed asset investment have no significant correlation with the investment in the sports cultural industry, which may be related to the unbalanced development level of industries in various regions and large data differences.

### **6.2. Suggestion**

The state should increase policy support and capital investment in the sports

cultural industry in underdeveloped areas in the central and western regions, promote coordinated development among regions, and narrow the gap between the east and the west. It should give play to the agglomeration effect and exemplary leading role of the sports cultural industry, promote industrial cooperation among regions, optimize resource allocation and experience exchange, and use industrial agglomeration to enhance the overall development level. Local governments should formulate targeted industrial development plans and supporting policies based on local conditions, increase fiscal investment, improve infrastructure, and optimize the industrial development environment. It is necessary to standardize and improve the statistical indicator system of sports and related industries, provide detailed and reliable data support for industrial development decisions, and conduct in-depth research on the mechanism of various influencing factors to provide references for formulating policies according to local conditions. Local governments should explore local characteristic sports cultural resources, cultivate regional brand events and industrial projects, support leading enterprises, improve the industrial system, promote the deep integration of sports culture, tourism, health, science and technology, and expand the industrial development space.

### Conflicts of Interest

The author declares no conflicts of interest.

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