Analysis Method of Coupling Correlation Between Sports Industry Development and Economy Based on Big Data

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Abstract

Based on the theory of grey system and agglomeration economy, this paper studies the correlation and coupling between sports industry and urbanization in Shanghai, and establishes the correlation and evolution relationship between sports industry and urbanization in Shanghai. In the new era, sports industry has played an important role in urban infrastructure construction, urban spatial layout optimization, industrial structure transformation, etc. This paper holds that: 1) The correlation between competitive industry and urbanization is a process of combining technological innovation, industrial integration, capital flow, capital aggregation and economic development, and sports industry is closely related to economic society, space and population urbanization. 3) From 2014 to 2018, the industrial development and urbanization showed a "U" curve, the largest being in 2014-2017, and the average being in 2017-2018.

Keywords: Urbanization; Industry; Association; Coupling; Evolution Characteristics.

1. Introduction

Sports is an important part of "Five Happy Industries" in the new era, and it has played a positive and external role in the construction of "Healthy China" and "National Fitness". With the support of various policies, the total output value of the national sports industry reached 1,007.8 billion yuan in 2006, and reached 98.3 billion yuan in 2006, with an average annual growth rate of 21.4%. In 2006, the output value of China's sports industry increased from 24.5 billion yuan in 2006 to 65.3 billion yuan in 2018, an increase of 31.5% over the same period of last year(Görling & Levy, 1993; Pomeau & Resibois, 1975; Sternhell, 1969). Sports activities are an integral part of a modern metropolis, the cultural foundation of a city and a "soft power". Sport and recreational participation foster large cultural links, makes living easier, and makes residents usually more satisfied and healthier than in societies where strength training isn't prioritized. Nations become better, wealthier, happier, and secure via sport and recreation. Through the creation of similar interests and ideals or the training of interpersonal key competencies for democratic societies, sporting participation may advance human dignity. Through uniting people and groups, sport improves traditions and culture. Urbanization is a social and economic problem of great significance, and scholars at home and abroad have made a lot of discussions on it. The quantity of individuals residing in metropolitan areas is rising, contributing to the ongoing housing shortage. This is brought on by a lack of expanding capacity for housing and public amenities, as well as impoverishment, illiteracy, and expensive architectural features that only a select few people can afford. However, due to the different concerns in various fields, the definition of urbanization is still inconclusive(García-Fariña et al., 2021; Vuister & Bax, 1993). The interaction among social processes as well as wealth creation inside a community is the main part of social economy. A distinctive cultural category or socio-political class's behavior inside a nation, particularly their purchasing decisions, could be attempted to be explained by social economists. On the research of urbanization, scholars in various fields agree that urbanization is a multi-level process of social and economic transformation. Among these factors, the development of economy is basic, the expansion of population, the expansion of cities and the improvement of people's quality of life. In the new historical stage, sports industry has become an important part of urban infrastructure construction, urban spatial layout optimization and industrial structure adjustment (Perera et al., 1996). So, the layout of land occupation influences the overall orientation of the urban design, connected to the urban expansion zone, as urban planning and pattern efficiency may integrate the functional areas and outer layers of structures. Therefore, it is very important to explore the interactive relationship between China's sports industry and urbanization(Kob & Andersen, 1995; Xu et al., 2021). "Coupling theory" is a kind of "contingency" which extends from the physical category to the sociological category. Generally, it refers to a special relationship in which more than two systems interact with each other. The index to measure

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the coupling degree between two or more systems is coupling. To examine the relationship between various sequences, the coupling correlation detrended analysis (CCDA) approach is suggested. The shortcoming of the previous CDFA approach that results in erroneous coupling connections is solved by the proposed technique. The higher the coupling degree between two or more systems, the stronger the correlation (Bruns et al., 2000; Gauthier et al., 1998; Hou et al., 2019). On the contrary, the smaller the coupling degree, the smaller the correlation degree (Gong et al., 2023; Hyysalo, 2009).

Therefore, there are no formulae available to calculate the connectivity between two components. Nevertheless, certain significant variables that affect coupling among components may be found. The complexities of the functionality, the kind of knowledge transfer among elements, as well as the communication device among configurations are the three that are most crucial. Therefore, the correlation coupling degree is generally used to conduct a deeper study on the properties of subsystems. Urbanization causes a lot of energy consumption, economic clustering, and industrialization to accelerate. These factors also cause substantial ecological contamination, which puts more strain on natural ecosystems. Studies on the coupling between urbanization and other systems mainly include the coupling between urbanization and ecosystem, the coupling between urbanization level and urbanization innovation, the coupling between urbanization and economic development, the coupling between population urbanization and regional urbanization, and the coordinated development between urbanization and tourism(Castiglione et al., 2021; Cheng, Wei, et al., 2022; Sykora et al., 2022). A lot of aspects go into efficient city planning because the main motivation for urban expansion is to increase the advantages of city life. These considerations involve community involvement, equity, as well as the wellbeing of the general population. The integration with sports system reflects the connection between sports and related systems, such as the connection between holding sports competitions and people's daily living standards, competitions and venues (Zhuo et al., 2020).

Second, the combination of sports and industry, that is, the combination of sports and industry, sports and tourism; Third, the coupling between China's sports industry and urban development, including the interaction and coupling between China's sports and urban development. Judging from the existing research results, there is still little interaction between urban development and sports industry in China (Cheng, Ma, et al., 2022; Nobre & Tavares, 2017; Wang & Li, 2017). Based on this, the author makes a comprehensive analysis of the relationship between China's sports industry and urbanization development by using the relevant data of Shanghai.

2. Materials and Methods

2.1 The Connotation of the Coupling Between Sports Industry and Urbanization

China's sports industry has experienced the transformation from planned economy to market economy, and it plays an important role in promoting urbanization. This paper analyzes the relationship between China's sports industry and urbanization from three aspects: 1) The connection and combination between sports industry and urbanization aims at promoting the coordinated development of sports industry and urbanization in China. Pupils have the chance to develop their management, involvement, and collaboration skills via the use of sports programs. Additionally encouraging health gains, physical activity gives kids an equal chance to participate in activities. Large sports organizations aid in the promotion of world poverty and reach a much wider audience with their efforts. Sports may indeed facilitate the improvement in poor countries. In the new historical period, sports industry plays an important role in promoting the development of urbanization, such as promoting the rational flow of urban elements and the reconstruction of urban functions. The impact of urbanization on China's sports industry has promoted the development of China's sports industry through factors and demands. Poor nutrition, pollution-related illnesses, communicable, unsanitary living situations, and other factors are among the primary health issues brought on by urbanization. At the 0.1 to 0.9 accurately expressed level, new urbanization will rise by 0.6744% to 0.5983% as smart manufacturing increases by 1% every year. In other words, scientific and technical development plays a comparatively larger role in encouraging urbanization in areas where new urbanization is undeveloped. Thus, it provides a greater development space for China's sports industry. 2) Through the reasonable combination of sports industry and urbanization, we can achieve the goal of combining with urbanization. The relationship between industry and urbanization is that the two systems influence each other, so as to achieve sustainable and high-quality development. An agrarian civilization becomes an industrialized society through the procedure of modernization. Manually and specialized employees are replaced by factory floors and increased manufacturing. In the past, this approach has sparked urbanization by generating financial expansion and employment possibilities that entice people to live in urban areas. It can be said that maintaining the proper relationship between sports industry and urbanization is a prerequisite for their mutual connection and influence.

2.2 The Mechanism of Coupling Between Sports Industry and Urbanization

Urbanization is a category with a wide range of meanings, and its definitions are different in different fields. Generally speaking, urbanization is a transition

from countryside to town, that is, the gathering of towns; Second, the centralization of non-agricultural production factors in cities and towns, that is, the economic agglomeration of cities and towns; Urban conceptualization can refer to the consolidation of residents of almost any municipality into a homogenous solution with a large number of people by area or a large portion of a country's residents living in metropolitan regions. Urbanization is the method through which large populations completely congregate in comparatively tiny regions to establish metropolises. Third, the change of rural spatial pattern, that is, the spatial agglomeration of cities and towns; Urban agglomerations are an organized urban structure that developed along with manufacturing and economic expansion that is focused on the metropolis. An urban agglomeration's municipalities are arranged in a distinct structure with functional divisions. Often, there is no connection between groups of heavily inhabited metropolitan areas and industry. The unique features are senescent populace, relatively low density of population, lower living expenses, declining earnings and rising poverty, and so on. Fourth, the lifestyle from the countryside to the city, that is, the social and productive gathering of the city. Industry is one of the important contents of China's national economic and social development, and its gathering role is increasingly obvious, which shows that China's competitive sports technology and sports have infiltrated with other industries, and are gradually in line with urbanization. This paper holds that, using the basic principles of aggregation economics, the relationship and coupling mechanism between China's sports industry and urbanization are studied. The link between micro and macroeconomic activities is referred to as aggregation. Individual personal entities' behavior is referred to as the microeconomic scale. The interactions among overall capital accumulation aggregates, mean values, or other accumulate are referred to as the macro scale. Through the correlation analysis of China's sports industry and urbanization, it can be seen that the urbanization level and the promotion of China's urbanization level are the inevitable result of promoting the development of China's sports industry. Numerous important economic concerns, including power, freshwater economic growth, ecology, disaster prevention, and adaptation and mitigation, may be managed concurrently by prioritizing sustainable urbanism within a larger web application framework. This paper discusses the internal mechanism of the relationship between sports industry and urbanization, that is, the essence of the relationship between the two is the external effect of which elements are interrelated. Sport for improvement refers to the utilization of sport to promote social growth. It functions on 3 different levels: assisting individuals in learning and developing; assisting a neighborhood in improving living circumstances; and, eventually, assisting a country in

settling disputes or their impacts. An instrument for growth is sports. To promote the development of urbanization through technological innovation and industrial integration, its internal mechanism is as follows: the relationship between sports industry and urbanization; Urbanization can promote the high-quality development of sports industry, including the flow and aggregation of elements. First, from the perspective of promoting the development of urbanization in China. With the increasing popularity of information technologies such as big data, cloud computing and the Internet of Things, the innovation in technology and management of China's sports industry has also been strengthened. For example, in the field of sports services, the technological innovation of competitive performance industry can improve the broadcast quality of competitions and enhance the public's ability to watch competitions. Participating in competitive sports may help kids develop sustainable success and teach them how to handle either success or disappointment. Students may pick up valuable lessons on tolerance, humility, and how to be gracious in loss and kind in success. The technological innovation of sports equipment manufacturing enterprises is conducive to improving the R&D and manufacturing capabilities of sports equipment and promoting the R&D and application of sports intelligent equipment; Through technological innovation, make the venues (venues) intelligent and convenient, and better adapt to mass sports and sports events. The characteristics and advantages of sports industry in terms of high degree of integration and strong correlation can improve the breadth and depth of its development by promoting the integration of sports with related industries such as entertainment, pension and tourism, so as to better meet the actual needs of urbanization. The second is to analyze the urbanization process of promoting the development of China's sports industry. Michael Porter believes that in the process of urbanization, the flow of various elements shows a process of evolution from low level to high level, transformation from labor-intensive to capital-intensive, and the joint influence of social, economic, political and other factors. With the arrival of knowledge economy, the traditional service function has been strengthened, and new production factors such as scientific knowledge, professional technology and information services have gathered in cities, speeding up the pace of modernization, making China's urban construction an important support for informatization, science and technology, scientific research, culture, society and culture, and promoting the rapid development of sports in China. Agglomeration is the term used to describe the occurrence of commercial activity clusters caused by businesses being adjacent to one another. It is a technique that focuses business growth in one area to increase the productivity of enterprises. The following industry characteristics are utilized to create metrics of

the applicability of Marshall's three concepts of industry accumulation to every industry ensemble: (1) amalgamation reduces transportation costs by putting input providers or individual customers closer together, (2) agglomeration makes it possible for labor market convolution layer, and (3) aggregation promotes intelligent systemic risks. From the perspective of industrial agglomeration, the relationship between sports industry and urbanization can be summarized as follows: technological innovation and industrial integration promote urbanization; Urbanization has promoted the development of China's sports industry.

2.3 Index Selection

Shanghai Sports Bureau and Shanghai Sports Health Industry Cooperative Research Institute jointly published the sports industry development index, and obtained the preliminary evaluation results; Secondly, the basic evaluation index of China's competitive sports industry is constructed by referring to relevant research results at home and abroad. Delphi method is used to evaluate China's sports industry. The Delphi approach stands out from conventional collective decision-making procedures thanks to four distinctive characteristics. These include confidentiality, evaluating iterations, quantitative collective responses, and professional assistance. The objective is to compile expert opinions and frequently utilize them to determine unanimity. The urbanization index is chosen because different research angles have different understandings of urbanization. Analyzing urbanization from the perspective of population

usually focuses on the discussion of urbanization problems caused by population migration; From the perspective of economics, we usually pay more attention to the role of economic development in urbanization; From the geographical point of view, it usually focuses on the analysis of the spatial evolution characteristics of urbanization; From the sociological point of view, we usually pay more attention to the problems of urban society. Sport is an effective medium for marketing because of its amazing capacity to bring people together. Numerous aid initiatives use sports to communicate with the public about regional growth concerns including knowledge, drugs and alcoholism instruction, preventative, philanthropic causes, advertising, and so on. Based on the papers published in famous academic journals at home and abroad, this paper uses Delphi analysis method to summarize 13 specific indicators, including economy, population, space and society (see Table 1). By polling a group of industry experts, the Delphi approach is a technique for reaching a consensus. Multiple rounds of surveys are given to professionals, and the results are compiled and presented to the organization at the conclusion of every cycle. Delphi has been referred to be a mixed-methods, experiential, and statistical technique. The methodology is challenging to categorize as a strategy because of the unidentified collecting of interpretive discussion, the closely organized nature of the procedure, and the statistically documented findings. Due to the limitation of space in this paper, the specific operation and calculation program of Delphi method will not be listed one by one.

Table 1

Sports Industry and Urbanization Index System

Target Layer	Criteria Layer	Index Layer
Sports Industry System	Sports Industry Scale	X1: Gross output value of sports industry
		X2: added value of sports industry
	Industry Contribution	X3: The added value of sports industry accounts for the proportion of GDP
		X4: Employees in sports industry
	Industrial Structure of Sports	X5: proportion of sports service industry
	Sports Industry Foundation	X6: Per capita sports consumption
		X7: Per capita sports ground area
	Sports Market Main Body	X8: Number of sports enterprises
Urbanization System	Economic Urbanization	Y1: GDP per capita
		Y2: the proportion of secondary and tertiary industries in GDP
	Population Urbanization	Y3: Proportion of urban population
		Y4: Urban population density
		Y5: The proportion of employees in the tertiary industry to the total employees
	Travel to Watch Industry	Y6: Per capita owned built-up area
		Y7: Per capita urban road area
		Y8: Per capita Park green space area
	Social Urbanization	Y9: Per capita disposable income of urban residents
		Y10: Number of College Students in Ordinary Colleges and Universities
		Y11: Per capita total retail sales of social consumer goods
		Y12: Number of health technicians per 10,000 people
		Y13: Every 10,000 people have public transport vehicles.

2.4 Data Sources

In view of the lack of basic information of sports

industry in China, and the lack of national and provincial official information, this paper chooses

Shanghai for empirical analysis. The statistical data of Shanghai sports industry in 2014-2018 was jointly developed and published by Shanghai Sports Bureau and Shanghai Sports Health Industry Cooperative Research Institute, which is official; Shanghai Urbanization The data of Shanghai urbanization in 2014-2018 mainly come from Shanghai Statistical Yearbook (2015-2019) and official website (http://data.stats.gov.cn/index.htm), National Bureau of Statistics. The selection and acquisition of the above materials are objective and authoritative, which can ensure the scientificity and feasibility of the materials.

3. Research Methods

In 1980s, according to the demand of this system, Mr. Deng Julong of China made an in-depth discussion on the influence mechanism of various elements of this system. The advantage of this method is that it can better reflect the intimacy degree and space allocation of internal factors of each system. A network that has both predictable and unpredictable data is referred to

as a "grey system." Grey numbers are intermission unknown factors that are used in the detailed definition of uncertainties in the gray systems concept, with the surface area of the range representing how accurate the information is. Based on the theory of grey system, the uncertain or changing system (such as correlation and contingency) is quantified by using grey correlation theory. Therefore, by using the theory of grey correlation degree, a coupling model between sports industry and urbanization in China is established. Following a grey relational production of the applies to situations, the connection among the assessment regions element and the attempted to strengthen is measured using the grey relational level. They support one another and have an impact on one another. The manufacturing regions progress from a lower to a higher extent of connection as they expand. The makeup of the sports sector has also altered as a result of this coupling mechanism. Additionally, the tourist sector has steadily developed in a way that is amicable with the sports business. The detailed process is detailed in the following formulas 1-9 (Table 2, Table 3).

Table 2

Shanghai Sports Industry Development Data

Age	2014	2015	2016	2017	2018
X1: Gross Output Value of Sports Industry (100 million yuan)	767.05	910.13	1045.87	1266.93	1496.11
X2: Added Value of Sports Industry (100 million yuan)	308.22	351.22	421.27	470.26	556.9
X3: The Added Value of sports Industry Accounts for the Proportion of GDP (%)	1.3	1.4	1.5	1.6	1.7
X4: Total Number of employees in sports enterprises (people)	26 yuan, 1974	04, 2167	12 yuan, 2504	54, 2835	75, 3333
X5: Gross output value of sports service industry/gross output value of sports industry (%)	55.3	60.3	64.6	65.5	75.8
X6: Per Capita Sports Consumption (RMB)	16-yuan 72	19-yuan 34 yuan	20-yuan 94	24-yuan 60	25-yuan 80 yuan
X7: Per Capita Sports Ground Area (m2)	1.74	1.76	1.83	1.96	2.23
X8: Number of Registered Sports Enterprises at the End of the Year (home)	79 38	79 38	89 10 yuan	9, 1148	6, 1628

Table 3

Shanghai Urbanization Development Data

Age	2014	2015	2016	2017	2018
Y1: GDP per capita (RMB/person)	23567.7	25123.45	28178.65	30632.99	36011.82
Y2: The Proportion of Secondary and Tertiary Industries in GDP (%)	99.5	99.6	99.6	99.7	99.7
Y3: Proportion of Urban Population (%)	89.6	87.6	87.9	87.7	88.1
Y4: Urban Population Density (person/square kilometer)	63 41	63 41	63 41	63 41	63 41
Y5: The Proportion of Employees in the Tertiary Industry to the Total Employees (%)	61.8	62.85	63.82	65.54	66.3
Y6: Per Capita Owned Built-Up Area (square kilometers/10,000 people)	4.41	4.39	4.37	4.36	4.34
Y7: Per Capita Urban Road Area (square meters)	4.11	4.27	4.37	4.51	4.58
Y8: Per Capita Park Green Area (m2/person)	7.33	7.62	7.83	8.19	8.49
Y9: Per Capita Disposable Income of Urban Residents (RMB)	48841.4	52961.86	57691.67	62595.74	68033.62
Y10: Number of College Students in Ordinary Colleges and Universities (10,000)	50.66	51.16	51.47	51.49	51.78
Y11: Per Capita Total Retail Sales of social Consumer Goods (RMB)	64666.47	70212.82	75493.79	81300.64	86630.7
Y12: Number of Health Technicians per 10,000 People (person)	sixty-eight	70 yuan	74 yuan	77 yuan	81 yuan
Y13: Every 10,000 People have Public Transport Vehicles (beacon)	11.97	12.36	12.7	13.94	9.04

4. Results

4.1 Shanghai Sports Industry and Urbanization have a Strong Coupling Relationship

The relationship between China's sports industry and urbanization was studied by using the method of grey correlation degree, and the influence of China's sports industry on urbanization was obtained. Taking Shanghai as an example, this paper makes a correlation analysis of the metropolitan area from 2014 to 2017, and obtains the correlation between sports industry and metropolitan area in each region. Industry is closely related to social urbanization and economic urbanization; There is a certain correlation between industry and population urbanization. This paper makes an empirical study on the relationship between sports industry and economic urbanization in China from three aspects: economy, society, space and population. It is found that there is a significant correlation between sports industry and economic urbanization in China, among which the correlation coefficients between sports industry and social urbanization are 0.7599 and 0.7599 respectively, and the relationship between sports industry and population urbanization is 0.7052 and 0.7599 respectively.

4.2 Shanghai Sports Industry and Urbanization Show an Inverted "U"-Shaped Coupling Relationship.

Figure 1 reflects the relationship and changing law between cities and sports industry. On the whole, during the period of 2014-2018, the relationship and coupling between China's sports industry and urbanization showed an inverted "U" shaped development process. On the whole, the degree of correlation coupling was very high, and it showed the characteristics of stages from high to low. Figure 1 and Table 4 shows that the change of correlation coupling among regions has obvious correlation (2014-2017) and neutral correlation coupling of "2017-2018".

Table 4

Changing values of correlation coupling

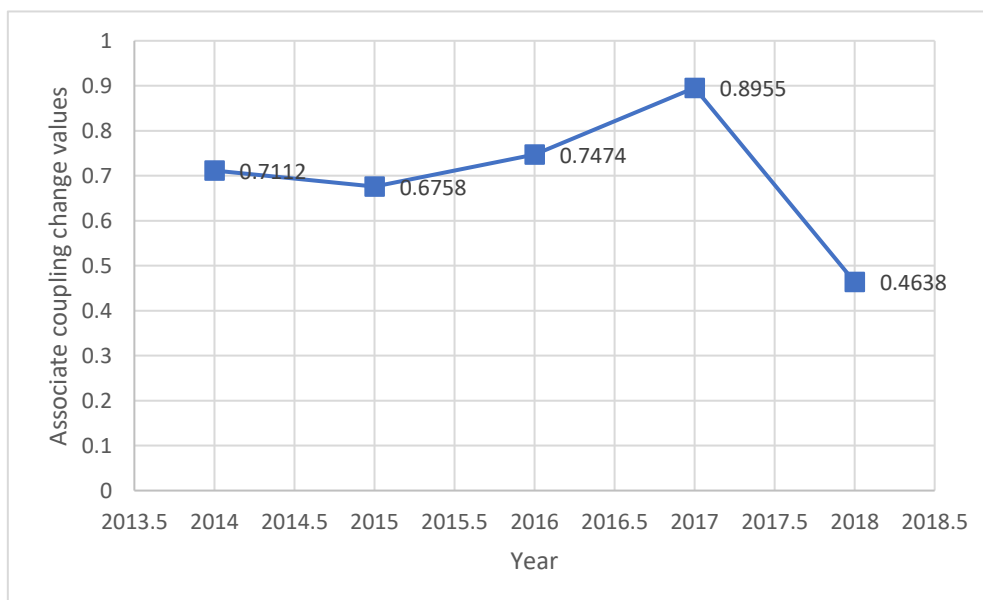| Year	Associate Coupling Change Values
2013	-
2014	0.7112
2015	0.6758
2016	0.7474
2017	0.8955
2018	0.4638
2019	-

Figure 1: The changing trend of the correlation and coupling between sports industry system and urbanization system (Source: Shanghai Sports Bureau.)

1) Strong correlation and coupling stage (2014-2017): Tables 4 ,5 and figures 2, 3 show that from the analysis of various indicators, urbanization indicators and other indicators, judging from the average annual growth rate of each indicator, the average annual growth rate of each indicator has been greatly improved, among which the annual growth rate of sports industry output value and industrial added value is 13.37%, while the development rate of sports industry is 11.14%; In the urbanization system, except for the proportion of urban residents and the average growth rate of the two indexes in the built-up area, the average growth rate of

the other 11 indexes is on the rise. Generally speaking, all indexes of China's sports industry system and urbanization system are on the rise, which promotes the mutual connection and development between China's sports industry and urbanization.

2) Medium correlation coupling stage (2017-2018): This paper analyzes the development of China's sports industry during this period. The average annual growth rate of various economic development indexes of sports industry in 2017-2018 is: the number of sports enterprises, the added value of sports industry, the added value of sports industry and the added value of sports industry increased by 41.75%, 18.42% and

18.09% respectively. Analyze from the process of urban development in this period. In 2017-2018, compared with 2014-2017, indicators such as the proportion of urban secondary and tertiary industries, the proportion of tertiary industries, the per capita built-up area, the per capita road area, and the number of public transport vehicles per capita decreased significantly. Generally speaking, the average growth rate of each index of China's urbanization system shows signs of slowing down. In a sense, China's sports industry system and urbanization system have developed from strong correlation in 2014-2017 to moderate coupling, and evolved in a "U" shape.

Table 4

Average annual growth rate of each index of sports industry system (%)

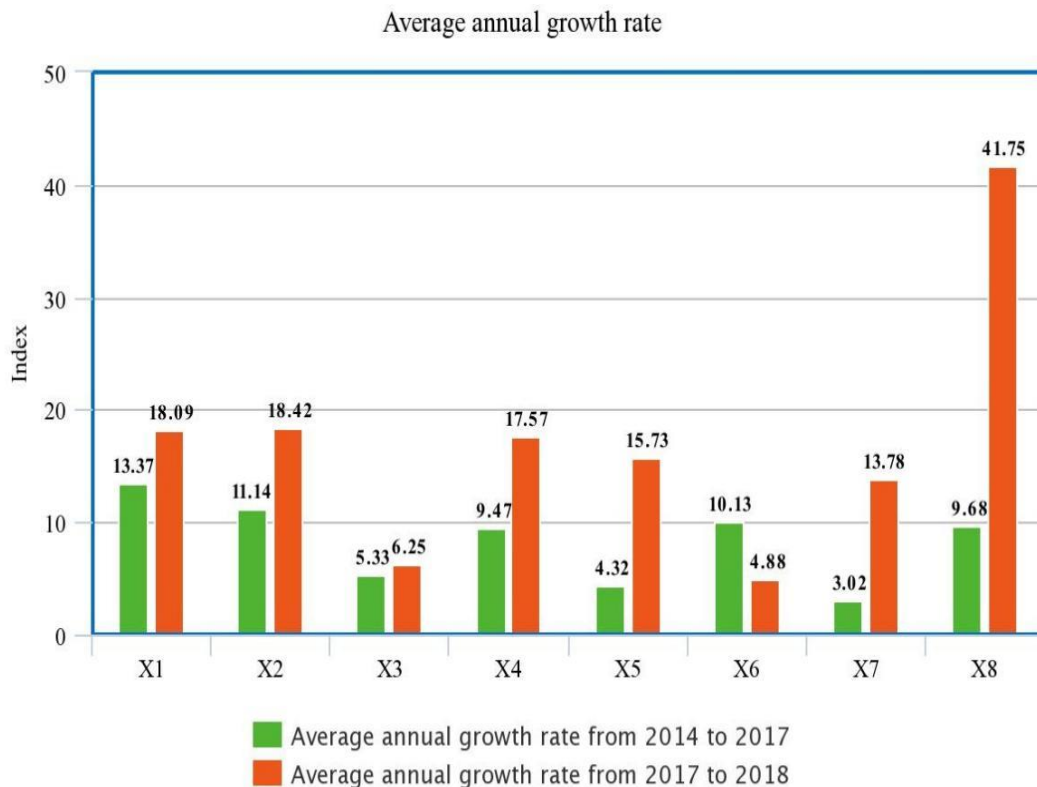| Index	X1	X2	X3	X4	X5	X6	X7	X8
Average Annual Growth Rate From 2014 To 2017	13.37	11.14	5.33	9.47	4.32	10.13	3.02	9.68
Average Annual Growth Rate From 2017 To 2018	18.09	18.42	6.25	17.57	15.73	4.88	13.78	41.75

Figure 2: Average annual growth rate of sports industry system (%)

Table 5

Average annual growth rate of each index of urbanization system (%)

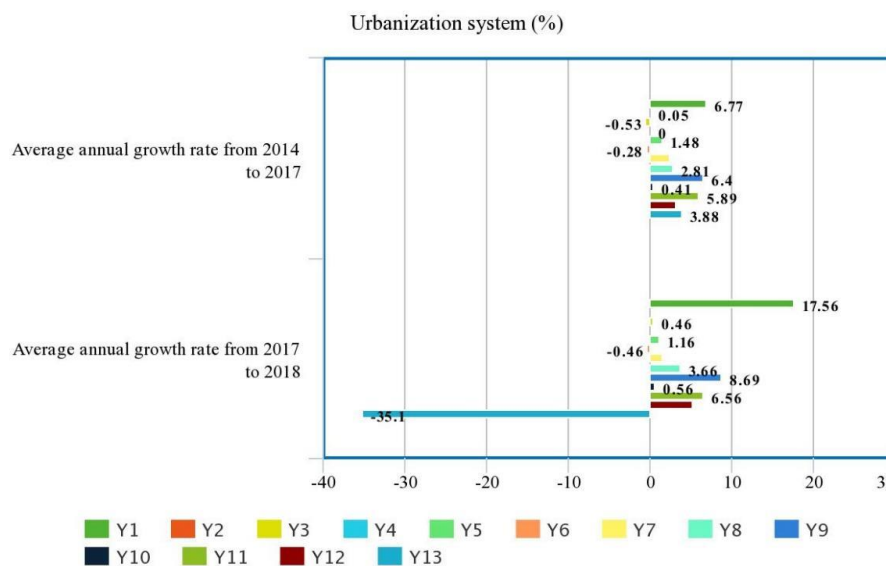| Index	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13
Average Annual Growth Rate From 2014 To 2017	6.77	0.05 Jin	-0.53	0	1.48	-0.28	2.35	2.81	6.4	0.41 Jin	5.89	3.16	3.88
Average Annual Growth Rate From 2017 To 2018	17.56	0	0.46 Jin	0	1.16	-0.46	1.55	3.66	8.69	0.56 Jin	6.56	5.19	-35.15

Figure 3: Average annual growth rate of urbanization system (%)

5. Conclusion

Through the research on the relationship and mechanism between sports industry and urbanization in Shanghai, the correlation index and coupling mode of sports industry and urbanization development are established, and the development characteristics are studied by the method of correlation coupling, and the following results are obtained:

1) The relationship and interaction between sports industry and urbanization is manifested in technological innovation, industrial integration, factor flow and industrial integration, and the internal relationship between factor flow and aggregation growth in the process of urbanization. 2) Sports industry is closely related to the urbanization of economy, society, space and population. Among these factors, the sports industry has the greatest correlation of 0.7660, which is weaker than the urbanization of population (0.7052). 3) During 2014-2018, the correlation coupling between China's sports industry and urbanization showed a U-shaped development trend. On the whole, the relationship between China's sports industry and urbanization showed a moderate and strong correlation, and showed a development process from high to low. Among them, there is a strong correlation between China's sports industry and urbanization in 2014-2017, while there is a moderate correlation in 2017-2018.

Acknowledgements

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