Research Article

Dynamic Modeling of High-Quality Development of Sports Industry Driven by Big Data Digital Economy

Bo Dong [ID]

Department of Physical Education, General Education Department, Wuhan College, China 430212

Correspondence should be addressed to Bo Dong; 8681@whxy.edu.cn

The overall structure layout of sports industry is inappropriate, and the effect is not ideal. The improper layout of industrial structure is not only an important factor hindering the healthy and rapid development of sports but also a key factor leading to the unsatisfactory effect of sports industry. In order to solve the problem that the potential of related industries is not brought into full play and the industrial quality is not high, this paper puts forward the research on dynamic modeling of high-quality development of sports industry driven by big data digital economy, understands the dynamic relationship between them through the research on the mechanism of high-quality development of sports industry driven by digital economy, and constructs the evaluation system of high-quality development of sports. The experimental results show that digital economy can give high-quality development power to the sports industry, improve industrial production efficiency, reduce production and transaction costs, promote industrial innovation, and provide diversified and personalized services for consumers. It is also helpful to the quality reform, efficiency reform, and power reform of the sports industry. However, in the initial stage of the integration of sports industry and digital economy, the weight of efficiency reform has not been significantly improved, and the efficiency of all production factors of sports industry needs to be further improved.

1. Introduction

With the transformation of China's economy from high-speed development to high-quality development, vigorously developing the digital economy and promoting its integration with the real economy has become one of the important strategies of China's modernization, and it is also an important measure to cultivate new growth points and new driving forces in various fields [1]. As a healthy and happy industry in the national industry, the sports industry plays an important role in helping the high-quality development of the national economy and stimulating social consumption and employment. Its rapid development makes the status and proportion of the sports industry in the national economy continue to increase [2]. At the same time, the development of digital technologies such as Internet, big data, and artificial intelligence makes the industrial transformation of the real economy a trend, which is conducive to the construction of a modern industrial system and open up a new driving force for economic development [3]. Therefore, the big data

digital economy can give impetus to the high-quality development of the sports industry, provide a new development mode and direction for the traditional sports industry, improve production technology and efficiency, improve the core competitiveness of the market, and provide consumers with more diversified, personalized, and accurate sports services [4]. However, at present, the research on the high-quality development of sports industry driven by big data digital economy is still in the primary stage, and there are still many problems that need to be further understood and studied, which need to be analyzed and studied from multiple angles, thinking directions and research dimensions.

The research innovation of this paper shows that big data digital economy can drive the sports industry and jump out of the traditional production and development mode of sports industry. Improve the production technology of sports industry and reduce production and sales costs so as to improve the production efficiency of sports industry and optimize the allocation of resources. At the same time, digital technology can help the sports industry collect, store,

integrate, and analyze relevant data and information. And apply this information to the fields of production, sales, innovation, and service, so as to achieve the purpose of adding value to the sports industry. At the same time, it can also force sports enterprises to carry out technological innovation and provide consumers with personalized, diversified, and accurate services.

Therefore, this paper proposes a dynamic modeling research on the high-quality development of sports industry driven by big data digital economy. The author believes that the sports industry driven by digital economy must be a dynamic change in the process of high-quality development, and the interaction between digital economy and sports industry development is also dynamic. The research on the dynamic relationship between them will help to clarify the connotation and role of the development of sports industry. This paper is mainly divided into three parts. The first part briefly expounds the current situation of the development of China's sports industry and related research. The second part constructs the relevant mechanism model and evaluation system of high-quality development of sports industry driven by big data digital economy. The third part is the simulation test of the evaluation system of high-quality development of sports industry driven by digital economy and analyzes the results.

2. Related Work

In the 1990s, China's abundant and low-cost raw materials, sufficient and low-cost labor force, and the potential sporting goods consumer market attracted many international sporting goods enterprises to invest in China. Therefore, many domestic small- and medium-sized enterprises were able to replace the processing opportunities and began a new model of technological innovation based on technological imitation. It not only reduces the cost of enterprise technology R&D but also improves the share of domestic low-end and middle-end markets [5, 6]. Since 2001, the scale of China's sports clothing market has continued to grow rapidly. By 2008, sports goods manufacturing has become the core driving force to promote the development of sports industry [7].

The U.S. subprime mortgage crisis in 2006 made the original profit model of domestic sports manufacturing industry unsustainable. National sports manufacturing enterprises such as Li Ning and hongxingerke keenly found the future development of China's sports industry in the crisis environment and began to carry out self-reform and reduce the scale of production investment and focus on scientific and technological research and development and corresponding sports service development [8, 9]. Although at the initial stage of the reform the performance of domestic enterprises undergoing reform decreased significantly year after year and the business was in a state of continuous loss, at the later stage of the reform, many enterprises also reversed the operating revenue from loss to profit and significantly increased the net profit [10]. During this period, the sports competition and performance industry and fitness and leisure industry in the domestic sports industry have developed rapidly, with a relatively stable consumer market and a growing trend [11].

In 2014, China's sports industry completed the accumulation of elements and endowments in the primary stage and began to enter the stage of deepening reform [12]. At this time, the reform of sporting goods manufacturing industry has also achieved certain results. The sports competition and performance industry has shown a good development trend, and the sports fitness and leisure industry has become the focus of the future development of the sports industry. By 2017, the structural proportion of the total output of sports fitness and leisure industry has increased to 2.6% [13].

Although China's sports industry still maintains a good development trend and with the application of digital technology has obtained a new driving force on the road of high-quality development [14], there are still many problems and bottlenecks in the high-quality development of sports industry. The position of sports industry in the whole national economy has been continuously improved in recent years, but investors' confidence in its investment still needs to be further improved [15]. At the same time, there is still no distinction between government and enterprises and between government and society. In addition, China's Internet economy lacks a scientific and necessary credit investigation environment in the process of rapid development, which makes many sports Internet enterprises have great financial risks and many enterprises close down.

3. Relevant Mechanism Model and Evaluation System

3.1. Mechanism of High-Quality Development of Sports Industry. The rapid development and continuous innovation of digital technology have changed the allocation mode of resources. At the same time, with the deepening of supply side structural reform, the sports industry realizes high-quality industrial development driven by digital economy, which is in line with the needs and requirements of China in economic transformation and upgrading in the new era. The mechanism of big data digital economy driving the high-quality development of sports industry can be divided into three levels: micro level, mesolevel, and macro level.

At the micro level, the sports industry can obtain the development power provided by the digital economy in the development process, jump out of the traditional economic model, and change the price transmission mechanism of the sports market, as shown in Figure 1. Technology R&D is very important for the development of enterprises, but the real support of enterprises still depends on everyone's continuous revenue and expenditure, and open source is the key. For sports enterprises, logistics cost is a major cost expenditure. Enterprises need to establish modern logistics concept and adopt standardized logistics management. At the same time, strengthen supply chain management, build a careful management system, and improve distribution efficiency. Compared with the traditional sports market, sports industry in digital economy has high fixed cost and low marginal cost in production. This enables sports enterprises to achieve the purpose of reducing the average cost of long-
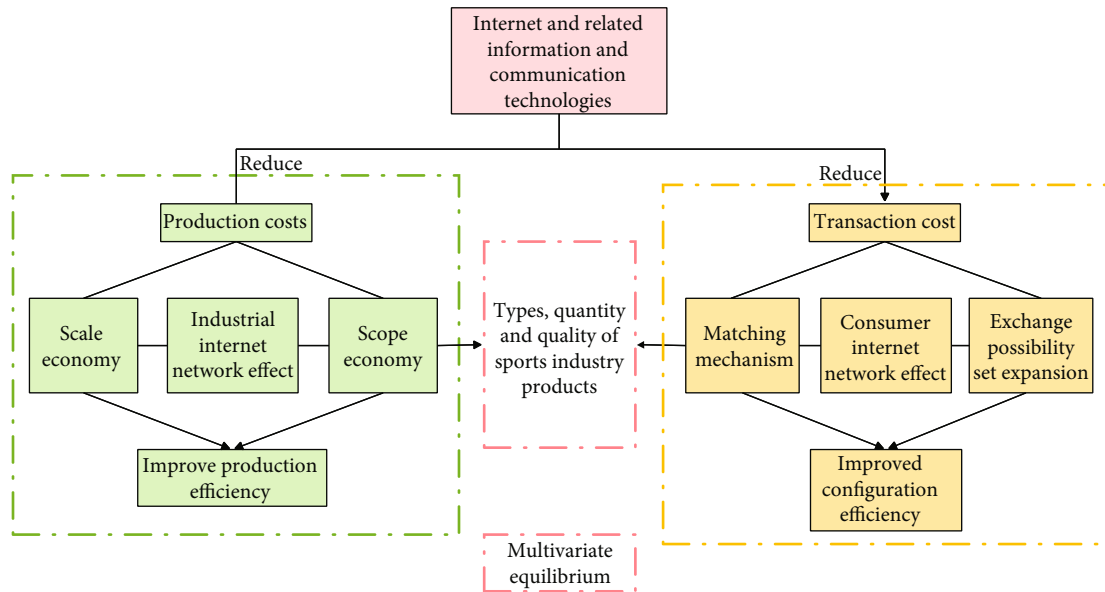
FIGURE 1: Micro mechanism diagram of high-quality development of sports industry driven by big data digital economy.

term production by continuously expanding the production scale, which are the economies of scale driven by big data digital economy. At the same time, digital economy can accumulate the number of consumers for the sports industry through the network effect generated by big data, Internet, and other information technologies, so as to reduce transaction costs, improve the supply and demand matching efficiency between consumers and products and services, and improve the turnover rate of inventory goods. While increasing the source of income, it broadens the business scope, promotes the development of new products and the improvement of overall services, meets the diversified consumption needs of consumers, and maximizes the effect of economies of scope. Through the big data and digital technology platform, the sports industry can also match the sports products with low demand to consumers in different regions on the basis of meeting the personalized and accurate consumption needs of consumers, greatly improve the efficiency of resource allocation, shorten the matching time between the two, and increase the demand and market share of goods.

At the mesolevel, the big data digital economy makes the traditional sports industry realize the transformation of digital technology, networking, and intelligence, and the transformation of the sports industry also has an impact on the investment and business model of traditional sports manufacturers and puts forward new requirements in line with the current situation. At the same time, the big data digital economy also strengthens the technical correlation between different departments of the sports industry, enabling the sports industry and other industries to build industrial clusters through synergy and positive feedback effect. Sports industry cluster is to effectively organize the sports industry elements of a certain region in an effective way. It is a way of resource allocation to engage in some economic activities that have the most competitive advantage for the region. It

integrates the concept and mechanism of sports industry and other industrial clusters. Based on the reasonable benefit distribution mechanism and supported by the core sports industry, it forms a multilevel and multistructure sports economic activity urban system and sports enterprise strategic alliance, which has a distinct industrial agglomeration advantage and radiation effect. Industrial clusters can strengthen the horizontal or vertical interaction between different industries and reduce the costs that other industries need to bear when adopting new technologies. The big data digital economy makes the sports industry jump out of the previous vertical and horizontal association organizational structure between manufacturers and manufacturers and manufacturers and consumers and change into an organizational structure with network collaborative association, so as to promote the upgrading of the internal structure of the sports industry and make it more reasonable and advanced. The advanced development of sports industrial structure is also an important link in the main industries of the national economy. Digital technology can help the sports industry realize the deepening of division of labor and coordination, the expansion of network externalities, and the reduction of industrial transaction costs, promote the sports industry to develop into a technology-intensive, high value-added, and high processing industry, and become an industry with advanced organizational structure. The integration of digital technology and sports industry not only reduces the transaction cost of sports industry but also expands the industrial integration boundary of enterprises, effectively integrates online and offline resources, and creates factor resource conditions for the development of sports industry. At the same time, the rapid extension of the consumer Internet to the industrial Internet has gradually expanded the consumption field in the digital economy era to the production field, which has promoted the industrial integration to have the trends of wide hunger integration, production and marketing
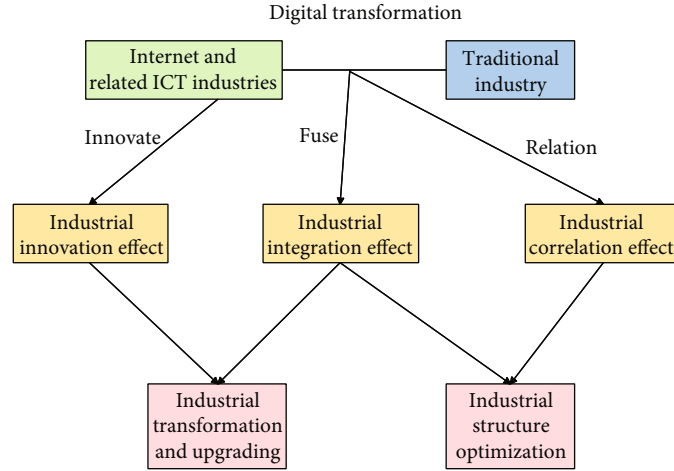
Digital transformation

Figure 2: Schematic diagram of high-quality development of sports industry under digital economy.

integration, and collaborative innovation. Figure 2 shows the mesolevel mechanism of high-quality development of sports industry driven by big data digital economy.

At the macro level, the high-quality development of sports industry driven by big data digital economy can help the high-quality development of economy. As a healthy and happy industry in the national economy, sports industry plays a very important role in promoting economic growth and stimulating employment. The main influencing factors of big data digital economy on the sports industry are the production input and output efficiency of the sports industry. Analyze the economic growth according to Solow's economic growth model, as shown in

$$Y = A * F(K, L) = K^{\alpha} * (AL)^{1-\alpha}. \tag{1}$$

Among them, the capital of sports industry is expressed as K, the labor is expressed as L, the technical development level of sports industry is expressed as A, and $F(\cdot)$ is expressed as a function.

According to formula (1), when the production capacity of the sports industry remains unchanged, it is necessary to increase or adjust the input proportion of the model parameter K, L, that is, increase the input of production factors of the sports industry or change the efficiency of resource allocation. In the traditional development mode of sports industry, the sports industry is affected by market-oriented allocation. Its main production factors include labor force, production technology, land resources, and capital. The new production factors of digital economy are data, which is the main line of digital transformation of sports industry and can also promote the emergence of new technical and economic characteristics. Therefore, in the big data digital economy, digital technology can help the sports industry achieve relevant data collection, storage, connectivity, and integration and then use these data as the basis to promote the innovation of sports enterprises and realize the provision of personalized and accurate sporting goods and related services. Then, analyze and apply the corresponding data to

optimize the production process and reduce the production and transaction costs, so as to realize the optimal allocation of resources and high-quality development of the sports industry.

When the function form in the model is changed or new variables are added, that is, the resource allocation mode of the sports industry is changed, different from the traditional economic model, the resource allocation leader of big data digital economy is a platform for rapid development, and data can expand the scope of resource allocation and promote the market, sports industry, and government to achieve the effect of complementary advantages in resource allocation. The digital transformation of the sports industry can also obtain more development power from the digital economy and change the resource allocation mode of the sports industry.

When the parameter A in the model is changed, the total factor productivity of the sports industry is improved through technology. The growth of total factor productivity of sports industry will produce technical and structural effects of sports industry, in which digital technology shows strong permeability, substitution, and synergy. The penetration of digital technology in turn will force the development and operation mode of the sports industry to change, and the application in the sports industry will form a comprehensive state. The new state and model of the sports industry generated by the integration of digital economy and sports industry are consistent with Moore's law of big data, so the capital accumulation of digital technology in sports enterprises will replace other capital. At the same time, the penetration of digital technology and capital substitution will enhance the synergy between it and other factors in the production process of sports industry, so as to improve labor productivity.

3.2. Construction of Evaluation System for High-Quality Development of Sports Industry Driven by Big Data Digital Economy. The high-quality development of sports industry driven by big data digital economy is a dynamic process. Therefore, the system constructed when evaluating it should also be combined with power, efficiency, and quality changes and build theoretical logic and principles with reference to

the corresponding index system. Therefore, there are three primary indicators, seven secondary indicators, and 23 tertiary indicators of the evaluation system in this paper, as shown in Figure 3.

The total factor productivity in the three-level indicators is obtained by Malmquist index method, as shown in

$$M_0(y_{t+1}, x_{t+1}, y_t, x_t) = \left[\frac{D_0^t(x_{t+1}, y_{t+1})}{D_0^t(x_t, y_t)} \times \frac{D_0^{t+1}(x_{t+1}, y_{t+1})}{D_0^{t+1}(x_t, y_t)} \right]^{1/2}. \tag{2}$$

Among them, the input and output vectors of period t and period $t+1$ are expressed as (x_t, y_t) and (x_{t+1}, y_{t+1}), respectively, the input distance function of production points and cutting-edge technology in the same period is expressed as $D_0^t(x_t, y_t)$ and $D_0^{t+1}(x_{t+1}, y_{t+1})$, and the input distance function of mixed period is expressed as $D_0^t(x_{t+1}, y_{t+1})$ and $D_0^{t+1}(x_t, y_t)$.

The change of technical efficiency in Malmquist index can also be divided into pure technical efficiency index and scale efficiency index, as shown in

$$\text{PECH} = \frac{D_{\text{VRS}}^{t+1}(x_{t+1}, y_{t+1})}{D_{\text{VRS}}^t(x_t, y_t)}, \tag{3}$$

$$\text{SECH} = \frac{D_{\text{CRS}}^{t+1}(x_{t+1}, y_{t+1})/D_{\text{VRS}}^{t+1}(x_{t+1}, y_{t+1})}{D_{\text{CRS}}^t(x_t, y_t)/D_{\text{VRS}}^t(x_t, y_t)}. \tag{4}$$

The calculation formula of diversification index of sports industry is shown in

$$d = \frac{1}{I_r} = \left[\sum_{k=1}^n \left(\frac{L_{kr}}{L_r} \right)^2 \right]^{-1}. \tag{5}$$

Among them, the industrial sector is expressed as k, the total number is expressed as n, the employment in the sports industry is expressed as L_{kr}, and the total employment in the sports industry in a region in r is expressed as L_r.

The rationalization index of sports industrial structure is calculated as shown in

$$S = \left[\sum_{i=1}^n \left(\frac{Y_i}{Y} \right) \sqrt{\left(\frac{Y_i/L_i}{Y/L} - 1 \right)^2} \right]^{-1}. \tag{6}$$

Among them, the industrial structure of various industries in the sports industry is expressed as Y_i/Y, and the labor productivity of i industry is expressed as $(Y_i/L_i)/(Y/L)$.

The agglomeration index of sports industry is shown in

$$Q_{ij} = \frac{(L_{ij}/L_j)}{(L_i/L)^{-1}}. \tag{7}$$

Among them, the output of sports industry i in j area is L_{ij}, the output of j area is L_j, the output of industry i is L_i, and the total output of sports industry is L.

The tax of sports industry is shown in

$$\text{Sports industry tax} = \text{unit income of main sports industry} \times 3\%. \tag{8}$$

In this paper, the entropy method is used to assign the weight of the evaluation index. Assuming that the number of research samples is m and the number of indicators of samples is n, the judgment matrix formula is shown in

$$X = (x_{ij}) m \times n. \tag{9}$$

Among them, $i = 1, 2, \cdots, m$; $j = 1, 2, \cdots, n$.
Standardize the index data, as shown in

$$Y_{ij} = (X_{ij} - X_{\min})(X_{\max} - X_{\min})^{-1}. \tag{10}$$

The maximum and minimum values of the j index of the i sample are expressed as $X_{\max}$ and $X_{\min}$, respectively.

The information entropy of the j-th index is calculated as shown in

$$H_j = -\sum_{i=1}^n Y_{ij} \frac{\ln Y_{ij}}{\ln n}, \tag{11}$$

$$Y_{ij} = \frac{y_{ij}}{\sum_{i=1}^n y_{ij}}. \tag{12}$$

Among them, $i = 1, 2, \cdots, n$.
The index weight is calculated as shown in

$$w_j = 1 - \frac{H_j}{\sum_{j=1}^n (1 - H_j)}. \tag{13}$$

The calculation of the secondary evaluation index E_2 requires the linear weighted summation of the evaluation value G_i' without quantitative processing. Take the index D_1 as an example, as shown in

$$E_{2D_1} = W_{3D_{11}} \times G_{D_{11}}' + W_{3D_{12}} \times G_{D_{12}}' + W_{3D_{13}} \times G_{D_{13}}' + W_{3D_{14}} \times G_{D_{14}}'. \tag{14}$$

For the calculation of the primary evaluation index E_1, try the linear weighted summation of the secondary index. Take the index D as an example, as shown in

$$E_{1D} = W_{2D_1} \times E_{2D_1} + W_{2D_2} \times E_{2D_2}. \tag{15}$$

The calculation of comprehensive index of high-quality development of sports industry is shown in

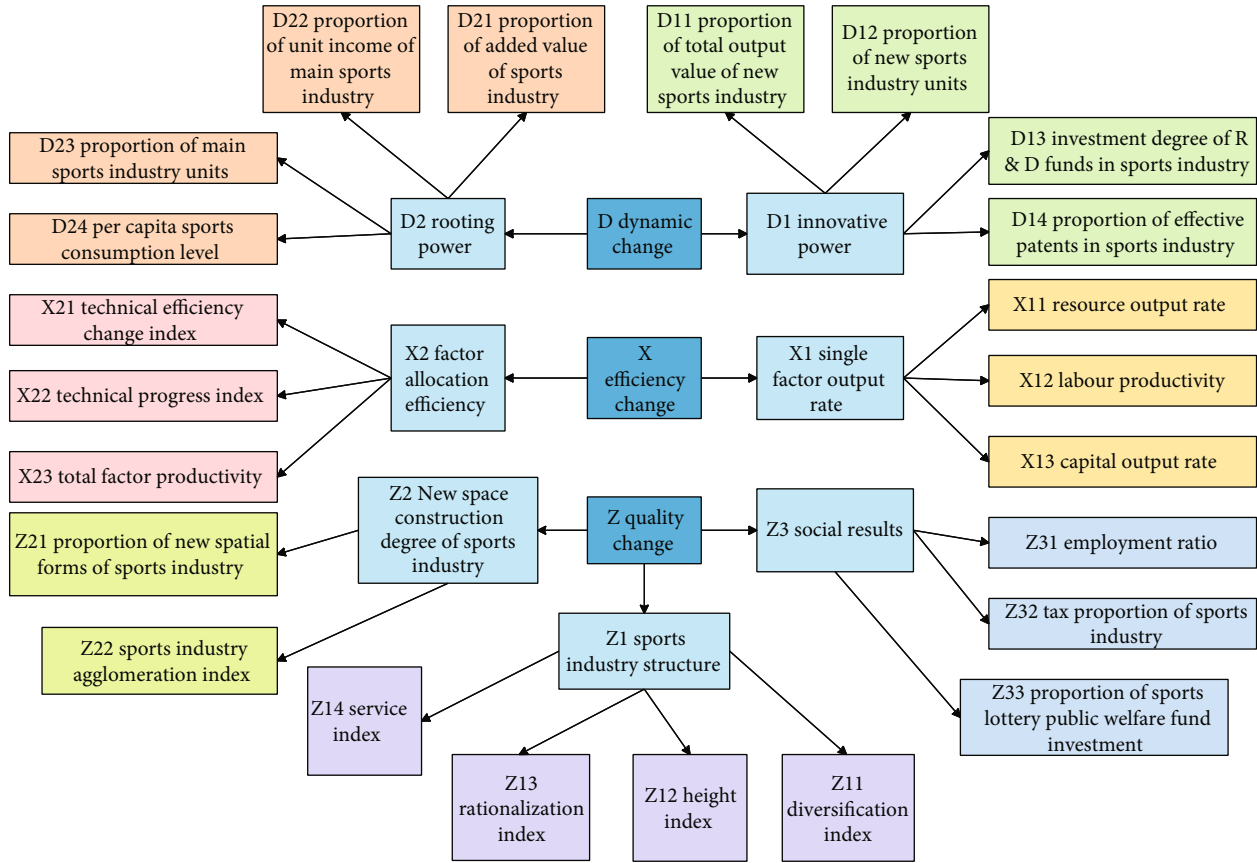$$E_0 = W_{1D} \times E_{1D} + W_{1X} \times E_{1X} + W_{1Z} \times E_{1Z}. \tag{16}$$

FIGURE 3: Evaluation system of high-quality development of sports industry driven by big data digital economy.

4. Simulation Test of High-Quality Development Evaluation System of Sports Industry Driven by Big Data Digital Economy

This paper selects the sports industry data of a city for simulation test and determines the weight of the third level evaluation index according to the entropy weight method. This paper analyzes the weight level of the city's sports industry in terms of industrial agglomeration level, unit output rate of the main body of the sports industry, and the scale of new industries after integration with the digital economy from 2017 to 2019. To some extent, this indicates that the sports industry of our city has begun to enter the high-quality development driven by the digital economy. Figure 4 shows the calculation results of the third level evaluation index weight and the evaluation index value after dimensionless processing, Figure 5 shows the calculation results of the second level index weight and the second level index, and Figure 6 shows the calculation results of the first level index weight, the first level index, and the comprehensive evaluation index E_0.

It can be seen from the data in the figure that the city's sports industry has improved in varying degrees from 2017 to 2019 in the level of industrial agglomeration, the output

rate of the main units of the sports industry, and the scale of new industries after integration with the digital economy, which indicates to a certain extent that the city's sports industry has begun to enter a period of high-quality development driven by the digital economy. It can be seen from the secondary indicators that the new space of the sports industry has the largest weight and the factor allocation efficiency has the smallest weight. If we look at the high-quality development of sports industry driven by digital economy from the three aspects of power, quality, and efficiency reform of sports industry, the weight of quality reform of sports industry in the city accounts for the highest proportion. Its sports industrial structure index shows that its structure has greatly improved in three aspects: industrial height, diversification, and service. It can be seen from the ratio of the scale of various formats of the city's sports industry to the total scale of the sports industry, as well as the ratio of the number of employees in the sports industry to the total working population, that the output value of the city's sports industry in sports management and performance activities, information services, and product manufacturing is higher than the corresponding growth rate of employment. Among them, the output of sports manufacturing industry is much higher than that of employment, while the output of sales, agency, and rental is smaller than that of employment. This shows that the city's sports industry has a high degree of
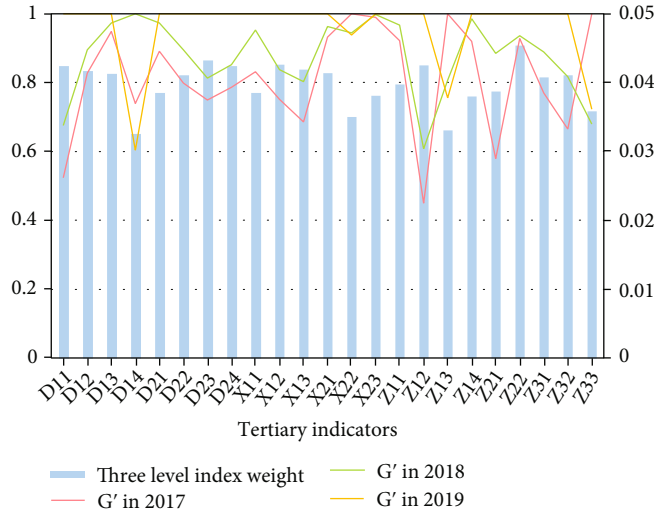
FIGURE 4: Three level evaluation index weight and index value of high-quality development of sports industry driven by digital economy.
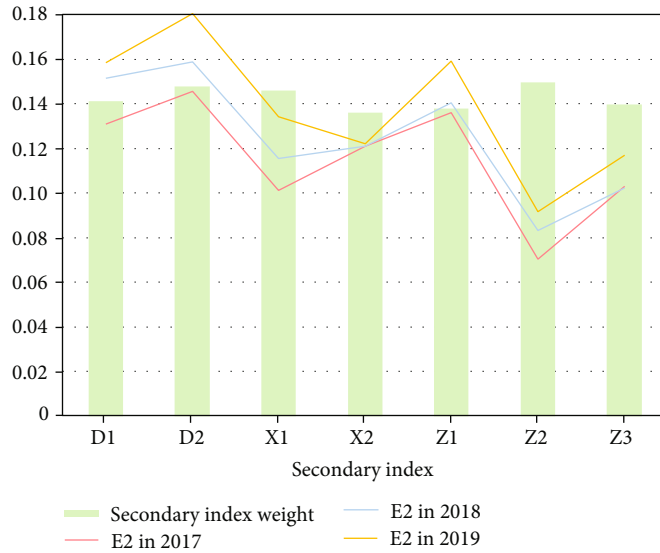

FIGURE 5: Calculation results of secondary index weight and secondary index.

digitization in manufacturing, service, and information, and the application of digital technology has begun to play a role, improving the output of corresponding fields and driving economic development. Compared with traditional offline sales and trade agents, digital technology has less penetration and is still in the process of transformation. At the same time, it can also be seen that the application of digital technology needs to be strengthened among various formats of the city's sports industry to improve the linkage and synergy between different industries, so as to better realize the adjustment of industrial structure and resource allocation.

In addition, the agglomeration index of the city has shown a continuous growth state in the past three years, which shows that its agglomeration degree has reached a high level and formed an effect. At the same time, the proportion of its new spatial form is also increasing, but the growth range is relatively limited. This shows that digital economy and digital technology can help the sports industry expand its scope of influence, but the digital transformation of the city has not been completed, so the scope of expansion is relatively limited. The weight and index value of three-level evaluation indicators for the high-quality development of sports industry driven by digital economy are shown in Figure 4.

Combined with the data in Figures 5 and 6, it can be seen that the dynamic change index of the city's sports industry is increasing, and the innovative dynamic index and rooted dynamic index are increasing for three consecutive years. It can be seen from the corresponding indicators that the city's sports industry has more effective patents for the sports industry in terms of information, biology, new materials, and other technologies. Although these patented technologies require large capital investment, they will also be applied in the production of the sports industry to help the sports
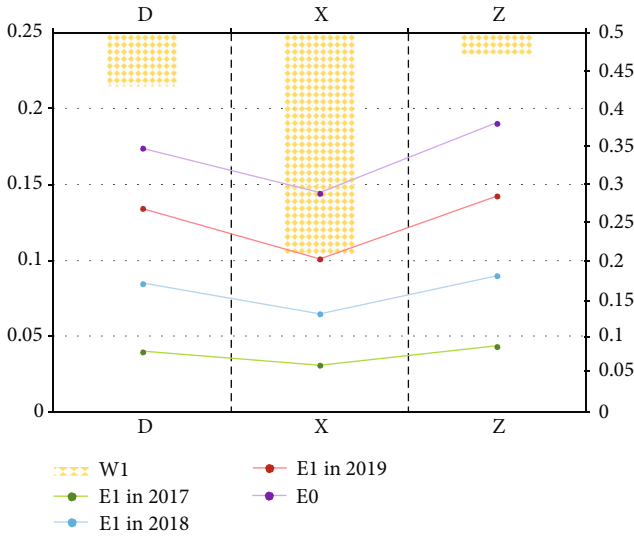
Figure 6: Calculation results of primary index weight, primary index, and comprehensive evaluation index E_0.

industry complete the corresponding transformation in the era of digital economy and reduce the restrictions on development, promoting its high-quality development. In addition, judging from the number of sports participants in the city, the consumer market of the city's sports industry has good potential. Data collection, analysis, and application combined with digital technology will make the city's sports industry realize further transformation and development. The consistency also shows that the driving force of digital economy on the sports industry is sustainable and long term.

From the perspective of efficiency reform indicators, the technical efficiency and total factor productivity of the city's sports industry have been relatively greatly improved. In terms of supply, it can meet the diversified sports needs of consumers and provide more personalized, accurate, and flexible sports services. The economic growth of sports industry has also changed from the original extensive type to the intensive type to enhance total factor productivity. The increase of productivity and capital output rate also promote the improvement of total factor production of sports industry. This shows that the penetration of digital technology and the deepening of capital can effectively help the sports industry improve total factor productivity, so as to promote high-quality development.

It can be seen from the comprehensive evaluation index in Figure 6 that the city's sports industry has entered the primary period of high-quality development driven by the digital economy, but the change range of efficiency change is less than that of dynamic change and quality change. Therefore, it is urgent to promote efficiency change in subsequent development. The efficiency reform of the sports industry needs to optimize the allocation of resources and improve technology and innovation, which requires the city to strengthen the application of digital technology in the sports industry and improve the quality of employees. At home and abroad, we need to change the layout of production factors, industrial space, and infrastructure, which needs to

strengthen the connection and synergy between different formats of sports industry. In the primary stage of the development of sports industry, it is necessary to continuously innovate technology, deepen capital, and invest in new production factors through the formation and diffusion of technology and economic paradigm, so as to achieve the purpose of improving production efficiency. At the same time, the city also needs to understand and control the sports industry through digital technology, so as to avoid repeated construction and resource waste of the sports industry.

5. Conclusion

With the development of digital technologies such as big data and artificial intelligence, the development scale of digital economy has been in a continuous and high-speed development state, which can provide a powerful driving force for the high-quality development of sports industry. As an important part of the national economy, the high-quality development of the sports industry is also an inevitable choice in the high-quality development strategy of the national economy. It is the inevitable trend of the sports industry in line with the market development. Therefore, this paper proposes a dynamic modeling research on the high-quality development of sports industry driven by big data digital economy and understands the dynamic interaction and interaction between them through the mechanism of big data digital economy driving the high-quality development of sports industry. At the same time, the evaluation system of high-quality development of sports industry is constructed on the basis of abiding by the basic principles. The test results show that the big data digital economy can give impetus to the sports industry, jump out of the traditional mode of production and development of the sports industry, improve the production technology of the sports industry, and reduce the production and sales costs, so as to improve the production efficiency of sports industry and optimize the allocation of resources. At the same time, digital technology can help the sports industry collect, store, integrate, and analyze relevant data information and apply the information in the fields of production, sales, innovation, and service, so as to achieve the purpose of adding value to the sports industry. At the same time, it can also force sports enterprises to carry out technological innovation and provide consumers with personalized, diversified, and accurate services. However, the integration of sports industry and digital economy in a city under test is still in the primary stage, and the improvement in efficiency reform is limited. On the one hand, because the transformation of the city's sports industry has not been completed, digital technology has only played a greater effect in some formats, and the connection and synergy between various formats are still relatively low. On the other hand, the high-quality development of the city's sports industry is still in the primary stage of technological innovation, and the driving force for economic development is limited.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The author declares no conflicts of interest.

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