

Retraction

Retracted: Research on the Correlation Model and Algorithm between Intangible Assets and Enterprise Value of Sports Listed Enterprises Based on Deep Learning

Mobile Information Systems

Received 25 July 2023; Accepted 25 July 2023; Published 26 July 2023

Copyright © 2023 Mobile Information Systems. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] X. Dong and Z. Xu, "Research on the Correlation Model and Algorithm between Intangible Assets and Enterprise Value of Sports Listed Enterprises Based on Deep Learning," *Mobile Information Systems*, vol. 2022, Article ID 3540011, 7 pages, 2022.

Research Article

Research on the Correlation Model and Algorithm between Intangible Assets and Enterprise Value of Sports Listed Enterprises Based on Deep Learning

Xiaoyan Dong ¹ and Ziqi Xu ²

¹*Sports Business School, Beijing Sports University, Beijing 100084, China*

²*School of Physical Education, Shanxi University, Taiyuan, 030006 Shanxi, China*

Correspondence should be addressed to Ziqi Xu; xuziqi@sxu.edu.cn

Received 6 April 2022; Revised 21 April 2022; Accepted 27 April 2022; Published 14 May 2022

Academic Editor: Hasan Ali Khattak

Copyright © 2022 Xiaoyan Dong and Ziqi Xu. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In order to explore the relationship between intangible assets and enterprise value of sports listed enterprises and build a multiple regression model, obtain the enterprise value of enterprise variables through parallel neural fuzzy network calculation, so as to verify the correlation between intangible value and enterprise value. With the development of economy, the intangibility of enterprises has been widely concerned. No matter what angle scholars study it from, our common concern is the research on the value of intangible assets and the definition of its existence. Taking sports listed companies as the research object, this study analyzes and discusses the correlation between intangible assets and enterprise value of sports listed companies by using the statistical analysis model algorithm based on deep learning and the method of constructing multiple regression model. The results show that intangible assets have a significant correlation with enterprise value, which is conducive for enterprises to promote the realization of enterprise value by improving intangible assets and provide favorable support for the sustainable development of the company.

1. Introduction

Intangible assets of enterprises are the inevitable product of economic development to a certain stage. There is no standard definition for them, but they are defined in a wide range relative to tangible assets [1]. Sports listed companies rely on the concept of sports to circulate and trade in the secondary market. The main body of the transaction is all shareholders and institutions. The value trend of sports listed companies in the secondary market is an embodiment of the intangible assets of enterprises. The stock houses and institutions trade the shares of enterprises according to the annual reports and operating conditions of listed companies, which is helpful to promote the development of enterprises in the primary market.

The value trend of listed enterprises in the secondary market is generally based on the operation status of the main body of the company, and the sharp decline of share price

will cause panic among shareholders and sell a large number of shares, thus affecting the image and operation of the enterprise. On the contrary, the operating condition of the company will also be directly related to the stock price fluctuation of the enterprise in the secondary market [2]. The intangible assets of listed sports enterprises are not only measured by the stock price, but all things that can produce economic efficiency for listed enterprises can be called intangible assets, such as brand effect, intellectual property rights, patented technology, and trademark [3].

Under the guidance of policies, the emerging sports industry has added color to national life and entertainment. Creating a model of health combined with leisure has not only promoted the revitalization of sports, but also promoted the development of national economy [4]. Based on the perspective of enterprise growth, the development of sports industry can improve the vitality and market competitiveness of enterprises, optimize the market environment,

promote technological innovation, create a good environment for the growth of enterprises, and strive to help enterprises become bigger and stronger. At the same time, listed companies also need to understand the value status and influencing factors of enterprises themselves. This paper analyzes the influencing factors of the assets of listed companies in the sports industry, which helps investors to effectively judge and control the risks in the investment process. At the same time, the benign development of the secondary market can also promote the benign development of listed sports enterprises in the market. There are only dozens of sports industry companies listed in Shanghai stock market, mainly because the revenue capacity of the sports industry is relatively weak compared with other industries, and the sports industry has only developed in recent years. Its technology and operation mode basically rely on its own exploration and learn from western experience. In the process of development, the state gives policy dividend support, but the difficulties in reality still restrict the development of some enterprises. This paper discusses the profit ratio, industrial structure, operation efficiency, and debt repayment ability of the sports industry in Shanghai stock market. The results show that the industrial structure of these sports listed enterprises is relatively single, but due to different business models, the profitability varies greatly, and the repayment ability is also different [5].

The intangible assets of listed enterprises are directly related to the value of the enterprise. Although the listed companies will have certain benefits under the influence of national policies and the market, the value related to the enterprise is the development status of the enterprise itself and the operation efficiency of the enterprise [6]. Due to the late start of China's sports listed companies, their scale and investment in other aspects are relatively simple, which limits their operating income [7]. At the present stage, there are structural contradictions such as insufficient effective supply of sports capital market, system structure deviation and dislocation of risk appetite, and the development is facing functional constraints [8]. By constructing a model and analyzing variables, this study discusses the causal relationship between intangible assets and enterprise value of sports listed enterprises. At the same time, the machine learning algorithm is used for regression analysis, so as to obtain the impact of the intangible assets of sports listed enterprises on the value of enterprises, which is helpful for enterprises to optimize the industrial structure and improve the earning ability in the process of development.

2. Influencing Factors of Intangible Assets of Sports Listed Enterprises

2.1. Description of Enterprise Value Influencing Variables. The intangible assets of listed sports enterprises cover a wide range. Some scholars deliberately emphasize the existence form of intangible assets of sports listed enterprises; some scholars pay attention to the economic function of enterprise intangible assets; some scholars have discussed the relevant factors in the market [9]. All these views are to analyze the existing form and value of intangible assets of sports listed enterprises. The value evaluation of intangible assets of

sports listed companies is also the direction of more attention in the research field of this industry.

The main indicators to measure the value of listed enterprises include net asset profit rate, profit per share, total asset turnover rate, total asset growth rate, and net income growth rate [10]. Using the principal component analysis model, this paper reduces the dimension of each index of the enterprise value of sports listed companies, extracts the principal component, and obtains the enterprise value of listed companies through calculation. At the same time, the correlation between them is analyzed to determine whether there is a certain correlation between enterprise value and various variables [11]. Carry out multiple regression analysis on the relevant variables, introduce machine learning, use neural network algorithm to analyze the impact of variables on enterprise value, and explain the above selected variables, as shown in Table 1:

2.2. Model Construction. Through principal component analysis, the dimension of the four indicators of the explained variables is reduced, and the total score is calculated to obtain the variable enterprise value (). Therefore, the constructed multiple regression model is as follows:

$$EV = \alpha + \beta IIA + \gamma_1 BPS + \gamma_2 IFA + \gamma_3 AF + \gamma_4 PDV + \gamma_5 PB + \gamma_6 SIZE + \varepsilon, \quad (1)$$

where α is a constant term, β is the regression coefficient before the explanatory variable, $\gamma_i, i = 1, 2, \dots, 6$ is the regression coefficient before the control variable, and ε is the random term of error.

At the same time, machine learning algorithms such as spatial convolution and fuzzy multicolumn convolution are introduced to push forward the time t axis for a certain period to form the variable prediction values of multiple intangible assets based on deep iterative regression from T1 to TN. The logic of the algorithm is shown in Figure 1:

Algorithm of convolution function is shown in Figure 2; the node function of FNN fuzzy neural network selects the sixth-order polynomial depth iterative regression basis function, as shown in formula (3); the node function of multicolumn fuzzy neural network selects the logarithmic depth iterative regression basis function, as shown in formula (4).

$$y = \int_{-\infty}^{+\infty} g(x)q(t-x)dt, \quad (2)$$

where $g(x)$: convoluted array function; $q(t-x)$: convolution kernel function; t : convolution pointer; x : convolution control variable; y : convolution results.

$$y = \sum_{i=1}^n \sum_{j=0}^5 A_j x_i^j, \quad (3)$$

$$y = \sum_{i=1}^n (A \cdot \log_e x_i + B), \quad (4)$$

where x_i : input value of the i th node of the previous neural network; y : output value of this node; n : the number of

TABLE 1: Description of enterprise value variables.

	Variable	Symbolic expression	Explain
Revenue capacity	Earnings per share (yuan)	EPS	After tax income and total shares
	Net income per share (yuan)	BPS	Shareholders' equity and total outstanding shares
	Net interest rate of assets (%)	ROE	Net interest rate and net assets
Solvency	Cash flow ratio	CR	Current assets, the need to repay debts, and the company's sustainable resources
	Asset liability ratio (%)	LEV	Total liabilities, total assets, and operating conditions of the company
Enterprise operation capability	Accounts receivable period	AR	The company's sales volume, amount of receivables, and bad debts
	Inventory turnover cycle	RSL	Company sales, inventory, and capital occupation cycle
	Total asset turnover	TAT	The company's sales volume and total assets and the proportion of the flow cycle of sales volume to capital
Development capacity	Growth rate of total assets (%)	NR	Growth rate of current total liabilities compared with the same period last year
	Net income growth rate (%)	RGR	Growth rate of current net income compared with the same period last year
	Turnover growth rate (%)	GDL	The current growth rate of enterprise sales compared with the same period last year

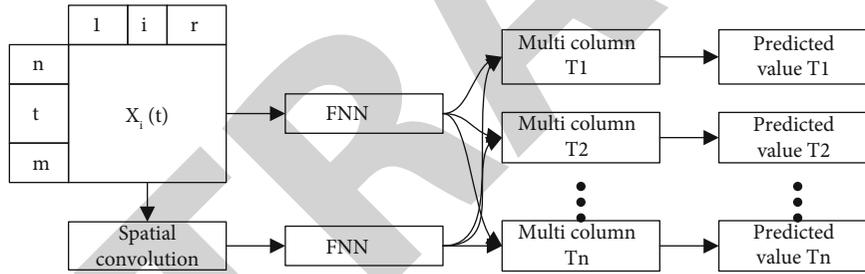


FIGURE 1: Logic diagram of data prediction algorithm.

nodes of the previous neural network; A, B : the variable to be regressed refers to the variable to be regressed of the j th order polynomial.

3. Empirical Analysis on the Correlation between Intangible Assets and Enterprise Value of Sports Listed Enterprises

This paper collects the data of 27 listed sports enterprises such as shenseg, Rhine sports, and TEDA from 2010 to 2019. After excluding the data of st *, gold certificate, and significant changes in the research range, a total of 157 effective data are collected. Descriptive statistical analysis and multiple regression analysis of these data were based on deep learning model algorithm.

3.1. Descriptive Statistical Analysis Results of the Correlation between Intangible

3.1.1. Assets and Enterprise Value. Descriptive statistical analysis was carried out on the effective data of 157 listed sports enterprises after the above treatment, mainly includ-

ing return on net assets (ROE), return on total assets (ROA), earnings per share (EPS), total asset turnover (TAT), quick ratio (AR), net asset growth rate (NAGR), net profit growth rate (NPGR), intangible asset growth rate (IIA), net asset per share (BPS), and fixed asset growth rate (IFA). The mean value and dispersion degree of these variables, such as amortization amount (AF), impairment provision (PDV), net asset ratio (PB), and asset size (SIZE), are statistically analyzed to obtain the data in Table 2.

Table 2 shows that ROE, ROA, EPS, TAT, AR, NAGR, and NPGR of these listed sports enterprises are the explained variables, and their average values are 7.0062, 5.3510, 0.2552, 0.5435, 2.1192, 23.6279, and 1.3873, respectively; IIA is the explanatory variable, and its mean value is 0.0749; BPS, IFA, AF, PDV, PB, and SIZE are control variables, and their mean values are 3.7166, 0.0974, 232453202.9459, 123050006.1349, 4.1718, and 22.1991. According to the data in the above table, draw Figure 2 below.

In Figure 2, the dimensional difference between different variables is large, so it is not suitable to use standard deviation to express the dispersion degree of variables. Therefore,

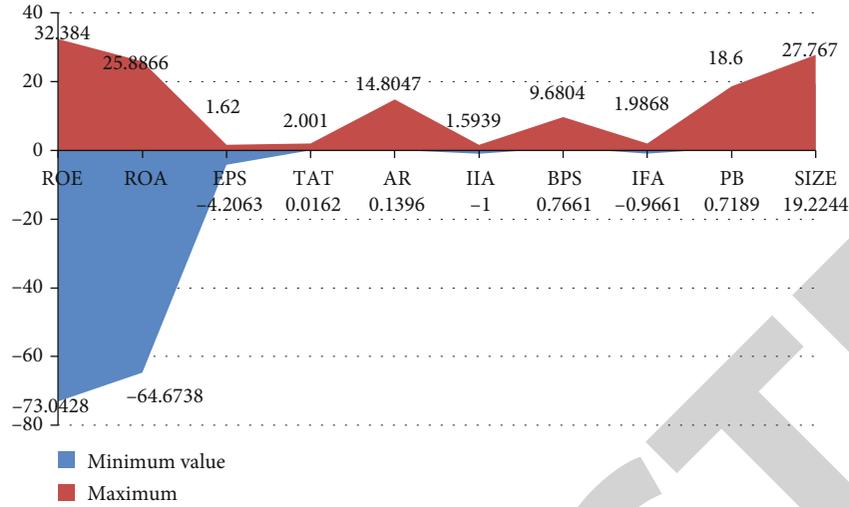


FIGURE 2: Statistical analysis of relevant variables of these sports listed enterprises.

TABLE 2: Descriptive analysis data of listed sports enterprises.

Variable	Minimum value	Maximum value	Average value	Standard deviation	Coefficient of variation
ROE	-73.0428	32.384	7.0062	10.327	1.474
ROA	-64.6738	25.8866	5.351	7.8017	1.458
EPS	-4.2063	1.62	0.2552	0.5049	1.9784
TAT	0.0162	2.001	0.5435	0.3692	0.6792
AR	0.1396	14.8047	2.1192	2.2531	1.0632
NAGR	-53.7632	609.104	23.6279	77.7043	3.2887
NPGR	-3152.198	1922.4514	1.3873	387.3294	279.1942
IIA	-1	1.5939	0.0749	0.4275	5.7096
BPS	0.7661	9.6804	3.7166	2.0484	0.5511
IFA	-0.9661	1.9868	0.0974	0.4162	4.275
AF	2774137.7	2.723E+09	232453203	505626961	2.1752
PDV	-83005022	3.002E+09	123050006	385781188	3.1352
PB	0.7189	18.6	4.1718	2.8798	0.6903
SIZE	19.2244	27.767	22.1991	1.6143	0.0727

the coefficient of variation is used to express the dispersion degree of variables. The larger the coefficient of variation, the higher the dispersion degree of variables. In this study, the coefficient of variation of NAGR is the largest, which shows that the dispersion degree of NAGR is high and the difference is the largest, while the dispersion degree of other variables is not much, which is relatively low.

3.2. Principal Component Analysis Results of Relevant Factors between Intangible Assets and Enterprise Value

3.2.1. Principal Component Analysis of Original Variable Data. Before the multiple regression analysis of the relevant factors between intangible assets and enterprise value, the principal component analysis method should be used to reduce the dimension of the seven indicators measuring enterprise value. Firstly, we should extract the principal components of all variables to obtain the principal components with strong correlation, and get the data in Table 3.

TABLE 3: Extraction results of principal components.

Variable	Initial eigenvalue	Extract
	1	0.906
ROA	1	0.914
EPS	1	0.875
TAT	1	0.946
AR	1	0.726
NAGR	1	0.736
NPGR	1	0.569

In Table 3, when the initial eigenvalue of the principal component to be selected for extracting the principal component by the principal component analysis method is ≥ 1 , it has the significance of extraction. The seven variables in the above table have the initial eigenvalue of 1, so they can be used as the extracted principal component. Among them, the extracted value is the common degree of all original

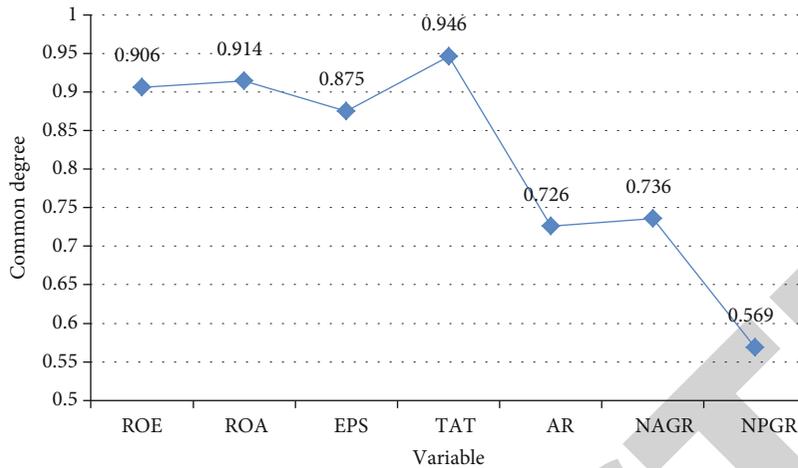


FIGURE 3: Extraction results of original variables.

variables. It can be seen from the table that the common degree of all variables is greater than 0.7, and only the common degree of three variables is close to 1. According to the data in the above table, Figure 3 can facilitate readers to compare the original data.

In Figure 3, it can be seen from the figure that the common value of only three variables is close to 1, so only three principal components are extracted, and the common value of all variables shows the proportion that these original variables can be explained by principal components, which also shows that most of the information of variables can be explained by principal components to reduce the loss of information.

3.2.2. Score Analysis of Principal Components of Variables. Because of the large dimensional difference of all the original variables selected, in order to avoid the impact of dimensional difference on principal component analysis, all variables will be processed in a unified way to obtain the data in Table 4.

In Table 4, from the principal component load matrix analysis in the above table, three components are extracted, of which the maximum load of the first principal component is 0.953, the maximum load of the second principal component is 0.851, and the maximum load of the third principal component is 0.869. Figure 4 was made according to the data in the above table.

In Figure 4, it can be seen that among the three extracted components, the first principal component has a greater load on the principal component of profitability, the second has a greater load on the principal component of growth solvency, and the third has a greater load on the principal component of operational capacity.

3.3. Multiple Regression Analysis. The significance test of multiple regression model is carried out for the variables. In the early stage, the linear regression model *F* test will be carried out for the variables, and the multiple regression model test will be carried out according to the results of the linear regression model.

TABLE 4: Data table of principal component standardization of variables.

Variable	Component		
	1	2	3
ROE	0.949	-0.019	-0.067
ROA	0.953	0.021	-0.078
EPS	0.931	0.042	-0.084
TAT	0.226	-0.373	0.869
AR	-0.035	0.851	0.026
NAGR	0.307	0.693	0.401
NPGR	0.714	-0.194	-0.144

Table 5 shows that there is a strong correlation between the enterprise value and the growth rate of intangible assets, net assets per share, growth rate of fixed assets, and provision for impairment, in which PDV, IIA, BPS, and IFA are the prediction variables and EV is the dependent variable. And the significance level α is 0.05. In the linear regression model, the probability *p* value of the significance *t* test of the regression coefficient of the growth rate of intangible assets, net assets per share, and impairment provision is less than the significance level α ; the probability *p* value of the significance test of the growth rate of fixed assets is greater than 0.05. Therefore, we believe that there is a significant difference between the regression coefficient of the growth rate of intangible assets, net assets per share, and impairment provision and 0, and there is no significant difference between the regression coefficient of the growth rate of fixed assets and 0. At the same time, from the perspective of collinearity statistics, the tolerances of DV, IIA, BPS, and IFA are greater than 0.05. This paper holds that the multicollinearity between explanatory variables and control variables is not serious.

4. Discussion

After the successful hosting of the Olympic Games in 2008, the world witnessed the achievements of China's sports

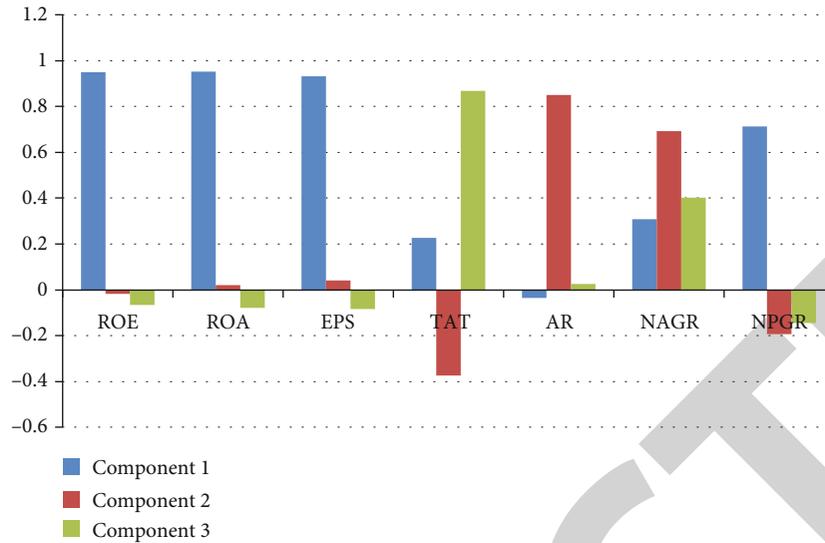


FIGURE 4: Data diagram of principal component standardized processing of variables.

TABLE 5: Significance test of multiple regression.

Model	Non standardized coefficient		Standard coefficient Beta	<i>t</i>	Significance	Collinearity statistics		
	<i>B</i>	Standard error				Tolerance	VIF	
(Constant)	-0.603	0.167		-3.609	0			
1	IIA	0.618	0.214	0.235	2.895	0.004	0.769	1.301
	BPS	0.163	0.042	0.298	3.911	0	0.879	1.137
	IFA	0.229	0.219	0.085	1.047	0.297	0.771	1.296
	PDV	-5.80E ⁻¹⁰	0	-0.199	-2.703	0.008	0.936	1.069

development. At the same time, it also stimulated the people's love and participation in sports, put forward the call for health and sports, and made sports a part of people's life and entertainment. At the same time, under the guidance of national policies, it has stimulated the market demand for the sports industry, so as to drive the development of the sports industry. The development of China's sports industry is relatively backward. So far, there are only dozens of sports listed enterprises, and the sports industry is relatively single, which restricts the development of enterprises. With the economic development, the industrial model is also changing. When intangible assets are mentioned more and more, the focus of enterprise development is not only limited to entities, but also the brand and the patented technology of enterprises which have become a part of enterprise assets. At the same time, it can bring substantial profits to enterprise development. Moreover, with the social progress and the intensification of the process of business diversification, people's way of thinking should also change.

Under the prosperity and development of the sports industry, listed companies in China's sports industry have brought rare development opportunities, stimulating people's enthusiasm for sports. With the increasing fitness, the demand for sports is increasing, ushering in excellent development opportunities for listed companies in China's sports industry. With the support of policies, the market has increased investment in the sports industry and analyzed

the value and influencing factors of listed companies in the sports industry. After all, the development trend of listed companies in the sports industry can further help investors invest in the sports industry reasonably, reduce investment risks, and promote its long-term development.

The intangible assets of sports listed companies are relatively empty, which must be combined with the real industry to better play its role. The market has increasingly recognized the binding mode between intangible assets and enterprise value, which also directly reflects that the impact of intangible assets on enterprise value is positive. Therefore, in the operation of sports listed companies, giving effective play to the role of intangible assets is conducive to the stable operation and development of enterprises.

Market demand dominates the change of economic model. Due to the incomplete management and law of intangible assets, people cannot quantify intangible assets and give standardized definitions, which seriously underestimates the value and role of intangible assets. When sports listed companies develop to a certain stage, they will pay attention to western countries and learn from their advanced ideas to drive the development of their own enterprises. Quantifying the intangible assets of the sports industry can help investors effectively predict the sports listed companies and reduce investment risks. At the same time, it can also help sports listed companies raise funds in the financing process and contribute to the sound development of sports listed companies.

5. Conclusion

It is concluded that there is a significant positive correlation between enterprise value and the growth rate of intangible assets, which shows that intangible assets can significantly promote enterprise value under the influence of various factors. With the rapid development of economy and the continuous change of industrial structure mode, the value of intangible assets has attracted more and more attention and plays a vital role in the development of enterprises, which helps to improve the core competitiveness of enterprises. The intangible assets of sports listed enterprises are a kind of wealth in the process of enterprise development. Compared with tangible assets, intangible assets are not specifically quantified. They often need to be combined with fixed assets to realize their value, so they cannot be evaluated separately [12]. However, there is no clear standard for the definition and value analysis of intangible assets. Although intangible assets can promote the realization of enterprise value in the process of economic development, the management of intangible assets is relatively backward due to the late start of China's sports listed enterprises compared with western countries [13]. By constructing a model, this paper analyzes the correlation between intangible assets and enterprise value of sports listed enterprises and uses neuro-fuzzy algorithm to calculate the data. In the future, with our people's love for sports, the sports industry will drive the sustainable development of the economy, and the management system and relevant policies of intangible assets of sports listed enterprises will be gradually completed to promote the cultivation of talents, so as to improve the development and construction of intangible assets and better promote the benign development of enterprise economy.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

There is no potential conflict of interest in our paper, and all authors have seen the manuscript and approved to submit to your journal.

Acknowledgments

This work was supported by the Planning Project of Philosophy and Social Sciences in Shanxi Province (No. 2019b025).

References

- [1] L. V. Xiaomin and J. Yimei, "How Chinese listed companies use intangible assets to create enterprise value," *Mall modernization*, vol. 17, pp. 142-143, 2014.
- [2] Z. Xiaoyou, H. Bingbing, and Z. Xiaopan, "Correlation analysis between intangible assets and enterprise value of listed companies," *Friends of accounting*, vol. 10, pp. 70-72, 2016.
- [3] C. Weixiu, "Analysis of competitive advantage of listed companies in China's sports industry," *Hebei enterprise*, vol. 8, pp. 53-55, 2021.
- [4] C. Yuqun and L. Tong, "Quanjing analysis and research on the operation status of sports listed companies in A-share market," *Journal of Hubei Normal University (Philosophy and Social Sciences Edition)*, vol. 40, no. 3, pp. 70-74, 2020.
- [5] Z. Qiyong and H. Haiyan, "The short-term impact of sports industry policy on the capital market value of sports listed companies," *Journal of Shanghai Institute of physical education*, vol. 40, no. 6, pp. 1-7+15, 2016.
- [6] Z. Li and W. Jing, "Research on operating performance of listed companies in domestic sports industry based on EVA," *Accounting newsletter*, vol. 24, pp. 125-128, 2016.
- [7] W. Lufeng, "Research on the relationship between ownership structure and enterprise value of listed companies in sports industry," *Economic Research Guide*, vol. 16, pp. 92-93, 2015.
- [8] Z. Qiyong, X. Kaijuan, and H. Haiyan, "Capital market supports the high-quality development of sports industry: mechanism of action, practical dilemma and path selection," *Journal of Shanghai Institute of Sport*, vol. 45, no. 12, pp. 35-49, 2021.
- [9] Z. Min and Z. Limin, "Research on the relationship between intangible assets, corporate value and operating performance of listed companies: based on the data analysis of listed companies in Shanghai stock market," *Caijing Lun Cong*, vol. 6, pp. 56-61, 2010.
- [10] X. Gu, "Accelerate the construction of financial informatization and improve the financial management level of sports state-owned enterprises," *China Sankei*, no. 6, pp. 129-131, 2022.
- [11] T. Hong, "An empirical study on the impact of competitive strategy on the performance of listed companies in sports industry," *Journal of Shanghai Institute of physical education*, vol. 42, no. 2, pp. 59-65, 2018.
- [12] Z. Zhaoyong and W. Yongqi, "Research on patent competitiveness of listed sporting goods enterprises," *Sports culture guide*, vol. 5, pp. 131-136, 2017.
- [13] R. Bo and D. Jun, "An empirical study on the competitiveness of listed companies in China's sports industry," *Sports science research*, vol. 21, no. 2, pp. 38-42+67, 2017.