Cover Letter

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The Spatial and Temporal Evolution and Spatial Correlation Pattern of the Integration and Development of the Digital Economy and Sports Industry in China

Dear Editor:

Thank you very much for your and the reviewers' comments on our manuscript (sustainability-2031066). The comments have provided excellent suggestions and helped us to improve the manuscript. We have revised this manuscript and update the abstract, introduction, literature, conclusion, added the contribution, structure of the work, limitations and future research. Because the above changes, the former title "The Spatial and Temporal Evolution and Spatial Correlation Pattern of the Integration and Development of the Digital Economy and Sports Industry in China" has been changed into "The Coupling Coordination Degree and Spatial Correlation Analysis of the Digital Economy and Sports Industry in China" in the revised manuscript. The changes in the manuscript have been highlighted in red font.

Please find attached a revised version of our manuscript. Our point-by-point responses to your comments are listed below. If you have any questions about this paper, please let me know.

We are looking forward to receiving your final decision.
Best wishes
Ya-wei Wang

Response to Reviewer 2 Comments

Point 1.: On the abstract:

a. The opening statement of statement of the abstract talks about 30 provinces but failed to state the country where they are. Authors should not assume readers are aware of the country of study (China). Please, kindly include China to remove ambiguity.

b. The method of analysis should be clearly stated.

c. Please reduce the policy suggestions to one or two as the abstract is a summary of your work. It should be apt and concise in order not to bored the readers.

Response1: Thanks for your advice. We have revised the abstract, clarified the country and analytical methodology, reduced the policy recommendations.

As following:

Driven by a new round of scientific and technological revolution and industrial transformation, the interactive and integrated development of the digital economy and sports industry is the objective demand of current economic development. In order to explore the coupling coordination relationship between the digital economy and the sports industry, this paper used the coupling coordination degree model and exploratory spatial data analysis method to analyze the coupling coordination degree and spatial correlation of the integrated development of China's digital economy and sports industry by taking the statistical data of 30 provinces, autonomous regions and municipalities in China from 2015 to 2019 as observation samples. The results show that the coupling coordination degree of China's digital economy and sports industry is low, showing an unbalanced development trend of "low in the west, high in the east, low in the north and high in the south". There is a significant positive clustering in the spatial integration of the two industries, and the degree of clustering increases year by year. It is necessary to establish a regional coordinated development mechanism, define the stage of regional integration, optimize the spatial pattern of coupled development, and promote the balanced development of the digital economy and sports industry. (see absearct，page 1, line 12 -26)

Point 2: On the introduction:

a. Authors should strengthen the motivations of the study and provide more arguments on contribution of the study. For instance, how does this study differs from previous studies?

b. The contribution of the snot well communicated. Please separate your contributions from the other points. I mean, start the contributions from a new paragraph.

c. There should be a paragraph at the end of the introduction on the structure of the work.

Response 2: Thanks for your advice. We have added motivation to the research in the introduction, a new paragraph that separately identifies the contribution of the research..(see introduction, page 2, line 30-52, page 3, line 1-5, page 4., line 1-18)

As following:

In recent years, scholars have shown great interest in the relationship between the digital economy and the sports industry. On the theoretical level, a large number of scholars have carried out relevant research, based on the connotation of digital economy and combined with the "push-pull theory", YE et al studied and elaborated the driving mechanism of the development of sports industry driven by digital economy [7]. Ren et al. believes that the sports industry gives play to economies of scale, economies of scope and the long tail effect through factor digitalization, process digitalization and product digitalization, forming the internal mechanism of the integration of digital economy and sports industry [8].Dong et al constructed the mechanism of the big data digital economy driving the high-quality development of the sports industry from the micro, meso and macro levels, and showed through simulation experiments that the digital economy could endow the sports industry with high-quality development power, improve the industrial production efficiency, and contribute to the quality reform, efficiency reform and power reform of the sports industry [9].At the same time, the digital economy is gradually being applied and infiltrated into different aspects of the sports industry,unmeng Chen, Li Haijie, CAI Jianhui, Luo Yuxin and Liu Chao respectively analyzed the dynamic mechanism, value dimension and strategic measures of digital economy in creative sports industry, sports leisure characteristic town, sports goods manufacturing industry, sports competition performance industry, ice and snow sports industry and other fields [10-14]. Shen Keyin et al. further refined the research content and program, and took the 5G technology-enabled live ice hockey game of Beijing Sports Media, the block chain-enabled "Sports Time Bank" of Bluebird Sports, and the Internet-enabled Zhejiang Huanglong Sports Center as examples to analyze the scene samples of the digitalization of sports service industry and make a study and decision on the development trend [15]. Pan Wei, Wei Yuan and Chai Wangjun respectively analyzed the current development predicament and optimization path from the perspectives of digital economy enabling high-quality sports industry, driving the upgrading of sports industry structure and boosting the digitalization of sports industry [16-18].(see page 2, line 30-52, page3, line1-6)

Existing literature has proved that digital economy can significantly improve the development of sports industry, but digital economy and sports industry are complex systems, without accurate objects and appropriate indicators, it is difficult to quantitatively analyze the relationship between them. In order to solve this problem, a large number of scholars have carried out relevant research. Considering the potential relationship between digital economy and energy transition, Muhammad Shahbaz et al. studied the impact of digital economy on renewable energy consumption and power generation structure, as well as the heterogeneity between digital economy and energy transition [19]. Li Linhan et al. estimated the level of China's digital economy from the perspectives of grey correlation, coupled coordination and spatial correlation network [20]. Li Xiangyang and Han Zhaoan constructed the index system between digital economy and high-quality development from different dimensions [21-22]. Liu Jun et al. analyzed the driving factors of digital economy based on SAR model [23]. Yang Song et al. used the coupling coordination degree model to measure the

coupling coordination degree of Chinese sports industry and electronic information industry [24]. Wang Yuzhen et al. conducted an empirical analysis of the coupling coordination relationship between the development of China's sports industry and tourism industry, and sorted the explanatory power of influencing factors of coordinated development from the greatest to the smallest through OLS regression model [25]. Yao Songbo et al. made an empirical analysis of the influence of sports industry agglomeration on regional economic growth by using static and dynamic panel models, and measured the level of sports industry agglomeration in various provinces and cities with the industrial proportion index [26]. Xu Jinfu et al. studied the development of sports industry and tourism industry from the perspective of industrial integration [27].(see page 3, line 7-30)

The above research results provide good experience for further deepening the research on the coupling development of digital economy and sports industry, but there is still room for further expansion. First, the existing research results mainly focus on the power, process, path and effect of the coupling of "digital economy and sports industry" from a qualitative level. Most of the literature analyzes specific cases. Describe the case phenomenon and analyze the existing problems, and put forward the countermeasures and suggestions to promote the coupling development of the two; Second, the research focuses on the one-way impact of digital economy on the high-quality development of sports industry, and the two systems interact with each other, so it is necessary to analyze the two-way relationship between them from the perspective of coupling and coordinated development. Third, the index system of the development of digital economy and sports industry exists independently, and the coupling development system between digital economy and sports industry has not been built, and there are few results of systematic quantitative research on the degree of coupling coordination between the two and the spatial distribution characteristics of this relationship.(see page 3 line31-45)

Based on this, the main contribution of this study is reflected in the following two aspects: First, it constructs the evaluation index system of the coupling development of the integrated development of digital economy and sports industry by using the coupling coordination theory, and empirically tests the coupling development level and dynamic evolution of the two in China based on the statistical data from 2015 to 2019, expanding the quantitative research on the integration development of the two. Second, the spatial correlation analysis method is adopted to analyze the spatio-temporal evolution characteristics of the integrated development of China's digital economy and sports industry, and the correlation and spatial agglomeration effect of the integrated development of digital economy and sports industry in 30 provinces, autonomous regions and municipalities in China (except Xizang and Hong Kong, Macao and Taiwan, hereinafter referred to as the provinces) are analyzed from the spatial perspective. In order to provide theoretical and practical reference for other countries (regions) in the world to quantitatively evaluate the complex coupling relationship between digital economy and sports industry. It provides quantitative decision-making reference for relevant departments in China and provinces to clearly position the integration stage, identify the two-way force between digital economy and sports industry, optimize the digital transformation strategy of sports industry, and improve the driving force of digital economy.(see page 3 line46-51, page 4 line1-13)

The rest of this article is organized as follows. The second part introduces the data source, index system structure and research methods. In section 3, the dynamic coupling relationship with time is studied. The fourth section further discusses the spatial correlation pattern of integrated development. Finally, Section V draws conclusions and recommendations.(see page 4 line14-18)

Point 3: On literature review

a. This section is totally missing. Was it intentional?

b. There is need for authors to review certain studies relating to the subject matter. Without reviewing what are existing, lacunas cannot be identified and contributions will be difficult to advance.

c. I suggest that authors create a section to review studies at least from 2018 to 2022 dealing with subject area of the study. It is good to recognize the contributions of others just like yours will be cited and reviewed after publication.

Response 3: Thanks for your advice.We have added a literature review section to review the 2018-2022 results related to the topic and identify the contributions of other authors to the research.

As following:

In recent years, researchers have shown great interest in the relationship between the digital economy and the sports industry. On the theoretical level, a large number of scholars have carried out relevant research, analyzed the theoretical basis and implementation path of the high-quality development of the sports industry driven by the digital economy and explored the dynamics, mechanism, and mode of integration of the digital economy and sports industry. Based on the connotation of digital economy and combined with the "push-pull theory", YE et al studied and elaborated on the driving mechanism of the development of the sports industry driven by digital economy [7]. Ren et al. believes that the sports industry gives play to economies of scale, economies of scope and the long tail effect through factor digitalization, process digitalization and product digitalization, forming the internal mechanism of the integration of the digital economy and sports industry [8]. Dong et al constructed the mechanism of the big data digital economy driving the high-quality development of the sports industry from the micro, meso and macro levels, and showed through simulation experiments that the digital economy could endow the sports industry with high-quality development power, improve the industrial production efficiency, and contribute to the quality reform, efficiency reform and power reform of the sports industry [9]. At the same time, the digital economy is gradually being applied and infiltrated into different aspects of the sports industry, Chen, Li, Cai, Luo, and Liu respectively analyzed the dynamic mechanism, value dimension, and strategic measures of the digital economy in the creative sports industry, sports leisure characteristic town, sports goods manufacturing industry, sports competition performance industry, ice and snow sports industry and other fields [10-14]. Shen et al. further refined the research content and program, and took the 5G technology-enabled live ice hockey game of Beijing Sports Media, the block chain-enabled "Sports Time Bank" of Bluebird Sports, and the Internet-enabled Zhejiang Huanglong Sports

Center as examples to analyze the scene samples of the digitalization of sports service industry and make a study and decision on the development trend [15]. Pan, Wei and Chai respectively analyzed the current development predicament and optimization path from the perspectives of the digital economy enabling high-quality sports industry, driving the upgrading of the sports industry structure, and boosting the digitalization of the sports industry [16-18]. (see page 2, line 30-52, page3, line1-6)

Existing literature has proved that the digital economy can significantly improve the development of the sports industry, but digital economy and sports industry are complex systems, without accurate objects and appropriate indicators, it is difficult to quantitatively analyze the relationship between them. In order to solve this problem, a large number of scholars have carried out relevant research. Considering the potential relationship between the digital economy and energy transition, Muhammad et al. studied the impact of the digital economy on renewable energy consumption and power generation structure, as well as the heterogeneity between the digital economy and energy transition [19]. Li et al. estimated the level of China's digital economy from the perspectives of grey correlation, coupled coordination, and spatial correlation network [20]. Li and Han constructed the index system between the digital economy and high-quality development from different dimensions [21-22]. Liu et al. analyzed the driving factors of the digital economy based on the SAR model [23]. Yang et al. used the coupling coordination degree model to measure the coupling coordination degree of the Chinese sports industry and the electronic information industry [24]. Wang et al. conducted an empirical analysis of the coupling coordination relationship between the development of China's sports industry and tourism industry and sorted the explanatory power of influencing factors of coordinated development from the greatest to the smallest through the OLS regression model [25]. Yao et al. made an empirical analysis of the influence of sports industry agglomeration on regional economic growth by using static and dynamic panel models and measured the level of sports industry agglomeration in various provinces and cities with the industrial proportion index [26]. Xu et al. studied the development of the sports industry and tourism industry from the perspective of industrial integration [27]. It compels the connotation foundation of digital economy and sports industry, provides reference for the construction of integrated development model of the digital economy and the sports industry and the selection of methods. (see page 3, line 7-30)

The above research results provide a good experience for further deepening the research on the coupling development of the digital economy and the sports industry, but there is still room for further expansion. First, the existing research results mainly focus on the power, process, path, and effect of the coupling of the "digital economy and sports industry" from a qualitative level. Most of the literature analyzes specific cases. Describe the case phenomenon and analyze the existing problems, and put forward the countermeasures and suggestions to promote the coupling development of the two; Second, the research focuses on the one-way impact of the digital economy on the high-quality development of the sports industry, and the two systems interact with each other, so it is necessary to analyze the two-way relationship between them from the perspective of coupling and coordinated development. Third, the index system of the development of the digital economy and sports industry exists independently, and the coupling development system between the digital economy and sports industry has not been built, and there are few results of systematic quantitative

research on the degree of coupling coordination between the two and the spatial distribution characteristics of this relationship. (see page 3 line31-45)

Point 4: In the last line of section 2 before Table 1, this statement is found in bold "see Error! Reference source not found." I do not think it is proper to state something like this. If you cannot find the reference, it is better to remain silent than putting this kind of confusion. Please, delete it. Please do the same to other areas where similar statement appears.

Response 4: We are extremely grateful that the reviewer pointed out this problem. We have checked the full text and made changes in other areas.

Point 5: The discussion of results should be linked to recent studies.

Response 5: We are extremely grateful that the reviewer pointed out this problem. It has become an academic consensus that digital economy can drive the high-quality development of sports industry. By using web of science and CNKI to search the research results in this field, we found that the author Bo Dong's (Mob.Inf.Syst. 2022, 9131081) research results are similar to those in this paper through the reading of a large number of literatures. Both of them explore the relationship between digital economy and sports industry by means of quantitative research. Firstly, an evaluation index system for the high-quality development of digital economy and sports industry is constructed, and then entropy method is adopted to determine the index weight. However, there are also differences. Bo Dong focuses on the dynamic relationship between the digital economy and the sports industry. With the data of the sports industry in a certain region as the experimental sample, he conducts a simulation test on the high-quality development evaluation system of the sports industry driven by the digital economy. (see page 20 line21-31, page 21 line1-5)

Point 6: Conclusion can be improved.

Response 6: We are extremely grateful that the reviewer pointed out this problem.e compare and discuss the existing conclusions with the previous research results and analyze the similarities and differences.

As following:

It has become an academic consensus that digital economy can drive the high-quality development of sports industry. web of science and CNKI were used to search the research results in this field. After reading a large number of literatures, we found that Bo Dong's research results were similar to this paper. Both of them explored the relationship between digital economy and sports

industry by means of quantitative research. Firstly, the evaluation index system of digital economy and the high quality development of sports industry is constructed, and then the entropy method is used to determine the index weight. However, there are also differences. Bo Dong focuses on the dynamic relationship between the digital economy and the sports industry. In this paper, the data of the sports industry in a certain region is taken as the experimental sample to conduct a simulation test on the high-quality development evaluation system of the sports industry driven by the digital economy. Bymeasure the spatial and temporal changes in the comprehensive development level of the digital economy and sports industry in 30 Chinese provinces from 2015 to 2019. The spatial and temporal divergence of the coupling coordination degree was analyzed, and their spatial correlation pattern was explored. The conclusions were as follows.

First, according to temporal changes in the comprehensive development level of China's digital economy and sports industry, the development of the digital economy showed an overall upward trend during 2015–2019, but the trend was relatively flat and the magnitude was small. The development level of the sports industry first increased and then leveled off, and the rise was not significant; there was a short decline in 2017 due to the negative growth of sports goods caused by the negative growth of the main business income of the manufacturing industry. One-third of the provinces in China had a higher comprehensive development level of the digital economy than the sports industry, while the development of the sports industry lagged the digital economy in the rest. In terms of the spatial pattern of the development level of the digital economy and sports industry, they gradually decreased from the southeast to the northwest. The gap between the two industries' development levels in most provinces was still obvious.

Second, according to the temporal evolution of the coupling and coordination degree of the digital economy and sports industry in China, the coupling and coordination degree of the two industries showed a trend of first increasing, then decreasing, and finally stabilizing. The overall coupling and coordination index was still low, and ideal coordination was not achieved. The level of coupling and coordination needs to be further improved. The spatial variation of the coupling and coordination degree of the digital economy and sports industry indicated that there were large regional differences in the coupling and coordination degree of the digital economy and sports industry in different provinces.

Third, from the perspective of the spatial correlation pattern of the coupled development of China's digital economy and sports industry, the two industries showed significant global and local positive spatial clustering patterns, and there were obvious "spatial spillover effects" and "Matthew effects" in the overall spatial correlations. The eastern and western regions belonged to the "H-H" and "L-L" agglomeration types, respectively, while the central region belonged to the "H-L" and "L-H" agglomeration types, where serious polarization existed. The eastern region was a growth pole with a high degree of integration, and both the digital economy and the sports industry were well developed, while the western region had a low level of integration, and thus, it needs to be further improved.(see page 20 line20-31, page 21 line1-36)

Point 7: The policy recommendations are weak in their present form. They can strengthen it by relating the findings to the recommends.

Response 7: We are extremely grateful that the reviewer pointed out this problem. We have rewritten policy recommendations by linking policy outcomes to recommendations.

As following:

First, establish a regional coordinated development mechanism to promote the balanced development of the digital economy and sports industry. The research results show that the comprehensive development level of the digital economy and sports industry is not balanced. The government should improve the top-level design, give targeted policy preference, financial support, and technical guidance to different regions, and speed up the construction of the digital economy and sports industry infrastructure according to local conditions. From the perspective of the digital economy, the development priorities and division of labor, and coordination mechanisms of the high-level, medium, and low-level regions are clarified. The experience and successful model of digital economy innovation and development pilot zones will be promoted nationwide. Continue to strengthen and give full play to the advantages of the development of the digital economy, make use of the achievements of the construction of the digital economy, and promote the digital transformation and in-depth development of the sports industry. At the sports industry level, we will implement the "Sports aid to Tibet" and other policies to promote the development of the regional sports industry in the western and central regions, and seize the "advantages of the northwest" to develop ice and snow sports so that the developed regions will drive the developing regionsand form a positive pattern of interactive development of the sports industries in the eastern, central and western regions.

Second, define the stage of regional integration and deepen the coupling and coordinated development. The eastern region should continue to maintain its development momentum, deepen the new business forms that integrate the digital economy with the sports industry, innovate the forms of services and products, and enhance the contribution of the sports industry to the development of the digital economy. At the same time, on the basis of ensuring its own development, it should actively transfer talents, technology, and experience to the outside, break the restrictions of administrative divisions, reduce industry barriers, and undertake the important task of driving the integrated development of China's digital economy and sports industry [1]. The western region should highlight regional characteristics based on its own resource endowment and industrial structure characteristics, and improve the application level of digital sports from the field of low difficulty and low cost. The central region should give full play to its geographical advantages of connecting the east with the west, and the south with the north. Taking the "Opinions on Promoting High-quality Development of the Central Region in the New Era" as an opportunity, the central region should accelerate the application of digital, networked, and intelligent technologies in the field of sports, promote inter-provincial cooperation and coordinated development of border areas, and create a carrier for the coupling development of digital economy and sports industry. We will further expand the space for their coupled and coordinated development.

Third, attach importance to the positive spatial correlation function of coupling development and optimize the spatial pattern of coupling development. Combined with the advantages of each province in the economy, resources, location, and industrial structure, the coupled and differentiated layout was carried out to enhance the coupled and coordinated high-quality development capability of the province itself. We will encourage neighboring provinces to develop comprehensive plans for coupled development and promote a new pattern of coordinated development among provinces. The "H-H" type proviences in the eastern region should, on the premise of maintaining a good development momentum, attach importance to innovative development and explore new business forms, new models, and new paths of coupled development. The "L-L" type proviences in the western

region can take Sichuan Province as the central city of the coupling and coordination of the two, and drive the improvement of the technical level, management mode, thinking concept, and value concept of the surrounding areas with the growth pole effect . The central region belongs to the type "H-L" and "L-H". It should focus on coupling development from its comparative advantages of huge market potential, profound cultural deposits, and rich resource factors, and promote the cooperation between the six inter-provincial border regions in the central region and the eastern border regions in terms of talent, technology, market, and industrial chain, and enhance the internal force of coupling development in the process of cooperation.(see page 21 line37-48, page 22 line1-50)

Point 8: Limitation and future research opportunity should be identified.

Response 8: We are extremely grateful that the reviewer pointed out this problem.We are extremely grateful that the reviewer pointed out this problem. According to your suggestions, we have revised the introduction extensively, added the literature review part, reviewed the achievements related to the topic from 2018 to 2022, identified the contributions of other authors to the research and the existing literature gaps, described the contributions of this paper in detail. During the revision process, it was found that the paper lacked the content of limitations and future research direction. Therefore, add this section in 5.3.

As following:

This paper only selects indexes from the aspects of informatization development, Internet development, digital transaction development, industrial economy and market size to construct the coupling evaluation index system of digital economy and sports industry. However, the coupling development of digital economy and sports industry is the result of multiple factors. The optimization of evaluation index and consideration of other related factors are important issues that need to be solved in further research. At the same time, this paper mainly uses the method of objective weighting (entropy value method) to determine the weight of indicators. In the future, the method of combining subjective weighting and objective weighting can be used to determine the weight of indicators more scientifically and reasonably. In addition, spatial Markov chain, Dagun Gini coefficient and other methods can be used to deeply analyze the spatial and regional differences of the integration development of digital economy and sports industry.(see page 23, line1-14).

Point 9: A lot must be done to improve the writing standard of the manuscript in terms of language structure (for instance, authors state in the introductory section last paragraph and I quote “the purpose of this study was to……”. In actual fact, purpose of a study should come in present form. Besides, the paragraphs contained too many lines. A standard paragraph should stand between 10 and 15 lines for clarity and avoidance of boredom for readers. Also, long sentences are many in the study.

Response 9: We are extremely grateful that the reviewer pointed out this problem. The article

has been checked and revised by MDPI English editor, and I will contacted the editor again to modify the language structure.