

Applied Mathematics and Nonlinear Sciences

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The Innovation of Communication Mode of Hunan Sports Culture in the Internet Era

Cong Guo^{1,†}

1. Dalian University of Foreign Languages, Dalian, Liaoning, 116044, China.

Submission Info

Communicated by Z. Sabir
Received December 18, 2023
Accepted December 28, 2023
Available online January 31, 2024

Abstract

Hunan culture is a unique cultural form in Hunan, and to some extent, it promotes the rapid development of the Hunan economy, which has a profound influence on the development of sports culture in the region. The Belo SMCR communication model is applied to the innovation of Hunan sports culture communication mode in this paper, and a system for evaluating the efficiency of sports culture communication is established. The DEA evaluation method is used to evaluate the relevant decision-making units affecting the dissemination efficiency of Hunan sports culture, and the Tobit model is introduced to analyze the influencing factors of the dissemination efficiency of Hunan sports culture. With regard to the dissemination efficiency of Hunan sports culture, the data from 2012 to 2019 are used as an example, and it is verified in terms of output redundancy, regression results and mediation effect. The results show that the redundancy of the output of Hunan sports culture on a spatial basis reaches 90.36%, the correlation coefficient of the technical input in the comprehensive efficiency of dissemination is 0.665, and there is an intermediary effect of the local culture industry on the dissemination efficiency of Hunan sports culture, with an R² fitting value of 0.357. Creating diverse dissemination channels through the use of new technologies is necessary to effectively enhance Hunan sports culture's communication influence in the Internet age.

Keywords: SMCR communication model; DEA; Tobit model; Decision-making unit; Huxiang Sports Culture.
AMS 2010 codes: 68M11

[†]Corresponding author.

Email address: 13478609163@163.com

1 Introduction

The continuous development and iteration of information technology signifies that people have entered the era of new media development and are being exposed to information and culture in a variety of ways [1-2]. Traditional sports are an essential aspect of China's outstanding traditional culture, which includes a plethora of cultural relics and serves as a symbolic representation of traditional culture. Strengthening the dissemination of traditional sports culture possesses distinctive practical significance both for the construction and development of Chinese sports and for the inheritance of excellent Chinese traditional culture [3-4]. Under the background of multicultural differences and conflicts, traditional sports should be combined with the characteristics of different regions, take cultural communication as a grip, take cultural mutual integration as a goal, deepen the understanding of the value of traditional sports cultural communication so as to promote the modernization of traditional sports communication [5].

National traditional sports are an important component of human sports culture, which is a cultural situation with national characteristics on the one hand and a cultural situation with traditional colors on the other hand [6-7]. Huxiang sports culture is formed on the basis of the development of traditional Huxiang culture, which has a distinctive and unique style homogeneous with the Huxiang culture, and also has a long cultural history. The development of Hunan sports culture plays an important role in the development of Hunan sports, in the influence of Hunan culture, and even in the construction of socialist spiritual civilization [8-9]. In the era of rapid development of the Internet, how to find a suitable mode of dissemination of Hunan sports culture, and further enhance the influence of Hunan sports culture is of vital importance to the development of society [10].

Sports culture refers to the collective beliefs, values, codes of behavior, traditions and practices associated with sports activities within a society or community and is the sum of material and spiritual wealth in the field of sports. Literature [11] applied the metacellular automata model to the modernization risk assessment of traditional sports culture and verified that the mutation factors in the modernization system of traditional sports culture would make the survival adaptability of sports culture reduced and unable to evolve, leading to the homogeneous self-disappearance of the modernization of traditional sports culture. Literature [12] explored the effective protection of national sports culture in the context of the implementation of rural revitalization strategy, and the integration of rural revitalization strategy and national sports culture resources can further enhance the development efficiency of rural revitalization and, to a certain extent, better achieve the inheritance and development of national sports culture. Literature [13] analyzes the outline of the development of Chinese contemporary sports culture and art with the research entry point of Chinese and Western cultural differences, and based on the special characteristics of the Chinese system, it is also necessary to make corresponding special changes for the sports culture industry, so as to better realize the innovative development of sports culture under the differences between Chinese and Western cultures. Literature [14] that sports can cross language barriers and national boundaries in the process of cultural exchange, fully attract the attention of the participants, and promote the deep integration of sports and culture, and the application of sports in cross-cultural communication can better help the country to carry out globalization development.

Sports culture has an immeasurable supporting and leading role for the country and the nation, and to give full play to the multiple social values and functions of sports, the dissemination of sports culture needs planning, and it needs top-level design and overall planning, and it needs the joint efforts of all walks of life. Literature [15] in order to be able to effectively evaluate the development level of popular sports and cultural organizations, the development level of popular sports and cultural organizations was established on the basis of the dice similarity binary linguistic variables in order to find a path that is more in line with the development of sports and cultural organizations and to

provide new references for the development of the dissemination of sports and culture. Literature [16] takes the idea of Olympic sports health as a comparison and analyzes the specific performance of the concept of health in Chinese sports culture, and the two have more similarities, which can be organically integrated to provide a new path for the wide dissemination of Chinese sports culture. Literature [17] examined intercultural communication between athletes and clubs and validated and analyzed it from the viewpoints of various disciplines and theories. From the results, athletes will move effectively between countries under the influence of sports culture, which realizes the dissemination of different sports cultures to a certain extent and also enhances the athletes' adaptability to sports culture. The Amsterdam Futsal Championship is used as an example by literature [18] to analyze how sport can enhance social inclusion, taking into account the importance of community sustainability and culture in sporting events. According to the findings, the effective dissemination of sports culture is driven by the realization of cultural sustainability by organizers and participants in sports events.

The construction of a model for sports culture dissemination, based on the Bello SMCR model, is an innovative approach in this paper, and an evaluation system is created to assess the effectiveness of sports culture dissemination. For the effective decision-making unit of sports culture dissemination efficiency, the DEA evaluation method is utilized to divide it into comprehensive efficiency, pure technical efficiency and scale efficiency, and the efficiency evaluation index is solved. In order to analyze the influencing factors of sports and cultural communication efficiency, the Tobit model was established by choosing the comprehensive efficiency, pure technical efficiency and scale efficiency of sports and cultural communication efficiency as the explanatory variables, the economic, social, technological and spatial inputs as the explanatory variables, and the cultural industry policy as the mediator variable. For the above relevant methods, the data on sports and culture development in Hunan from 2012 to 2019 are used as research examples, which are validated in various aspects, such as cultural dissemination efficiency, output redundancy, correlation test, regression analysis and mediating effect analysis, and are used to explore the path to improve the dissemination efficiency of sports and culture in Hunan.

2 Methodology

At present, the rapid development of the social economy also promotes the rapid updating and development of science and technology to a large extent, and the application and popularization of Internet technology has greatly changed people's way of life. National traditional sports culture is a national treasure that has survived through long-term development and evolution, and it has an important influence on the development of social economy and culture. Therefore, national traditional sports culture should actively follow the trend of the times and carry out innovative dissemination and development through the Internet. This chapter focuses on analyzing the sports culture dissemination model and related technologies, which provides the basis for the following validation of the effective model of sports culture dissemination in Hunan.

2.1 Evaluation system construction of sports culture communication efficiency

2.1.1 Belo SMCR propagation model

SMCR model is a kind of information dissemination model which was first put forward by Bello, focusing on explaining the interaction between the "communicator", "communication elements," and "audience". The structure of the SMCR model is shown in Figure 1. The structure of the communication model is shown in Figure 1, which believes that information should cover at least four elements in the process of communication: source, message, channel and host, and each element

is composed of several factors. The effectiveness of information dissemination mainly depends on these four elements and their interrelationships. Introducing the analytical framework of the SMCR model into sports culture dissemination will be helpful in explaining the process of sports culture dissemination and finding effective dissemination paths.

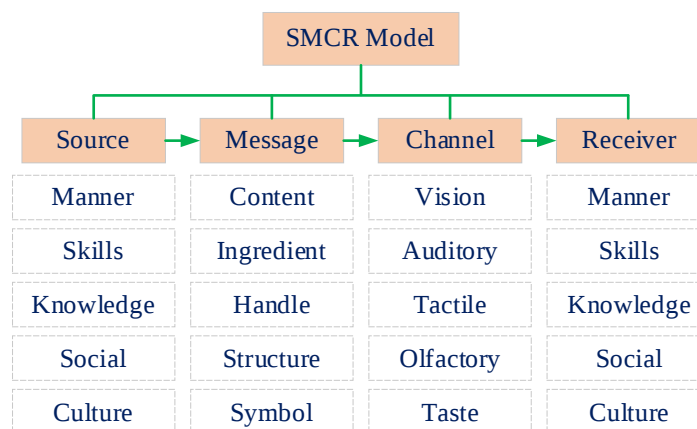


Figure 1. The Bello SMCR propagation model

The source is the initial initiator of the whole information dissemination process and also the main body of dissemination, which plays a decisive role in determining the content, quantity, mode of expression and the choice of channel of information. Information is the carrier of the process of cultural communication. Combining the content of the communication information with the needs of the audience, targeted coding of the communication information and its presentation in the form of text, images, audio, video, etc., will help to achieve a good communication effect. The channel is the bridge that passes information from the source to the host, which includes various communication tools. The signal lodging serves both the function of receiving information and providing feedback.

Compared with other communication models, the SMCR model emphasizes the proactive role of the host in the process of information transmission and believes that attitudes, communication skills, knowledge, social systems and culture all influence the host's acceptance, understanding, use and feedback of information.

2.1.2 Evaluation system for the efficiency of sports culture communication

Relying on the Bello SMCR communication model, the source, information, channel and host need to be emphasized in the communication of sports culture, and the efficiency of sports culture communication is mainly realized in four dimensions: economic, social, technological and spatial. The economic and social dimensions provide the source, information and channel support for the enhancement of sports culture communication efficiency, while the technological and spatial dimensions realize the carrier of sports culture communication mailboxes, which provide a guarantee for the further enhancement of sports culture communication efficiency. Based on this, this paper establishes a sports culture communication efficiency evaluation system, the specific content of which is shown in Table 1, including 4 primary indicators and 16 secondary indicators.

Table 1. Evaluation system of sports culture communication efficiency

Level 1 index	Level 2 index	Coding
Economic dimension (A)	Economic base	A1
	Cultural output	A2
	Cultural consumption	A3
	Cultural investment	A4
Social dimension (B)	Social foundation	B1
	Cultural tradition	B2
	Culture consciousness	B3
	Cultural services	B4
Technical dimension (C)	Supporting technology	C1
	Cultural talent	C2
	Cultural innovation	C3
	Cultural radiation	C4
Spatial dimension (D)	Spatial basis	D1
	Cultural resources	D2
	Cultural facility	D3
	Cultural landscape	D4

Relying on the Bello SMCR communication model, the source, information, channel and host need to be emphasized in the communication of sports culture, and the efficiency of sports culture communication is mainly realized in four dimensions: economic, social, technological and spatial. The economic and social dimensions provide the source, information and channel support for the enhancement of sports culture communication efficiency, while the technological and spatial dimensions realize the carrier of sports culture communication mailboxes, which provide a guarantee for the further enhancement of sports culture communication efficiency. Based on this, this paper establishes a sports culture communication efficiency evaluation system, the specific content of which is shown in Table 1, including 4 primary indicators and 16 secondary indicators.

2.2 Selection of Measurement Methods and Modeling

2.2.1 Data Envelopment Analysis (DEA) models

Data Envelopment Analysis (DEA) uses a mathematical planning model to evaluate the relative effectiveness between evaluated objects with multiple inputs and multiple outputs. The method takes each evaluated object as a decision-making unit (DMU), views the decision-making unit as a whole, determines the effective production frontier by analyzing the input and output ratios, and judges the DEA effectiveness of each decision-making unit based on analyzing the distance between each decision-making unit and the effective production frontier.

C^2R is the first DEA model, the other DEA models are C^2R models based on the successive expansion of the C^2R model assumes that the returns to scale are unchanged, the scale efficiency and pure technical efficiency will be combined into the total technical efficiency of the decision unit, which is used to determine whether the decision unit is technically efficient or not [19].

It is assumed that there are t evaluated decision units, each with m input variables and n output variables. Where x_{ij} denotes the input of the j th decision unit to the i th input, $x_{ij} > 0$, y_{rj} denotes the output of the j th decision unit to the r th output, $y_{rj} > 0$, v_i denotes a measure of the i th input, u_r denotes a measure of the r th output, $i = 1, 2, \dots, m; r = 1, 2, \dots, n$, x_{ij}, y_{rj} are known data, which can be obtained from the historical information, and v_i, u_r are variables. Corresponding to a set of weight coefficients, then:

$$\begin{cases} v = (v_1, \dots, v_m)^T \\ u = (u_1, \dots, u_n)^T \end{cases} \quad (1)$$

The input matrix is denoted as:

$$X = \begin{pmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{pmatrix} \quad (2)$$

The output matrix is represented as:

$$Y = \begin{pmatrix} y_{11} & \cdots & y_{1n} \\ \vdots & \ddots & \vdots \\ y_{m1} & \cdots & y_{mn} \end{pmatrix} \quad (3)$$

x_{ij} is the total amount of inputs of the j nd decision unit for the i rd type of inputs, $x_{ij} > 0$, y_{rj} is the total amount of outputs of the j th decision unit for the r th type of outputs, $y_{rj} > 0$, v_i is a measure of inputs for the i th type of inputs, the weight coefficients, and u_r is a measure of outputs for the r th type of outputs, i.e., the weight coefficients.

Each decision unit has a corresponding efficiency evaluation index, viz:

$$h_j = \frac{u^T y_j}{v^T x_j} = \frac{\sum_{r=1}^n u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}}, j = 1, 2, \dots, t \quad (4)$$

Where $x_j = (x_{1j}, \dots, x_{mj})$, $y_j = (y_{1j}, \dots, y_{nj})$.

Evaluating the efficiency of decision unit j_0 , in general, a larger h_{j_0} indicates that decision unit j_0 is able to achieve a relatively large number of outputs with a relatively small number of inputs. If decision unit j_0 is evaluated to see if decision unit j_0 is relatively optimal among the n decision units, it can be examined what the maximum value of h_{j_0} is when the weights are varied as much as possible. Now the efficiency of decision unit j_0 is evaluated, with weight coefficients v and u as variable vectors, the efficiency index of decision unit j_0 as the objective, and the efficiency index of all decision units as constraints, the following optimization model is constructed, i.e.:

$$(P) \begin{cases} \max \frac{u^T y_0}{v^T x_0} \\ s.t. \frac{u^T y_j}{v^T x_j} \leq 1, j = 1, 2, \dots, t \\ u \geq 0, v \geq 0, u \neq 0, v \neq 0 \end{cases} \quad (5)$$

where $x_0 = x_{j_0}, y_0 = y_{j_0}, 1 \leq j_0 \leq t$.

Perform the Charnes-Cooper transformation on this fractional plan such that:

$$s = \frac{1}{v^T x_0} > 0, \omega = sv, \mu = su \quad (6)$$

Then the equivalent linear programming problem is obtained, i.e:

$$(P_{C^2R}) \begin{cases} \max h_{j_0} = \mu^T y_0 \\ s.t. \omega^T x_j - \mu^T y_j \geq 0, j = 1, 2, \dots, t \\ \omega^T x_0 = 1 \\ \omega \geq 0, \mu \geq 0 \end{cases} \quad (7)$$

Taking its pairwise planning and introducing the slack variable s^-, s^+ , the C^2R -model is obtained which can be expressed as:

$$C^2R \begin{cases} \min \theta = h_{j_0} \\ \sum_{j=1}^n x_j \lambda_j + s^+ = \theta x_0 \\ \sum_{j=1}^n y_j \lambda_j - s^- = y_0 \\ \lambda_j \geq 0, j = 1, 2, \dots, n \\ s^- \geq 0, s^+ \geq 0 \end{cases} \quad (8)$$

θ denotes the technical efficiency value, x_j, y_j denotes the inputs and outputs of the j rd decision cell, and x_0, y_0 denotes the inputs and outputs of the evaluated decision cell. When $\theta_0 = 1$, and $s_0^- = 0, s_0^+ = 0$, the decision cell j_0 is DEA valid, indicating that the output Y_0 is optimized at the present input X_0 . When $\theta_0 < 1$, the decision cell DEA is invalid, indicating that the inputs can be reduced to a θ proportion of the original inputs X_0 without a reduction in the original outputs Y_0 .

A decision unit for which DEA is valid is characterized by the fact that it is not possible to reduce the amount of any existing input any further unless one or more new inputs are added or certain types of

outputs are reduced. The amount of any existing output cannot be increased any further unless one or more new inputs are added or certain types of outputs are reduced.

2.2.2 Mathematical definition of the Tobit model

In the actual analysis, the dependent variables whose data samples are truncated or censored are restricted dependent variables, and therefore, both have to be analyzed by regression using the Tobit model rather than the least square method (OLS). Truncated data are data samples where no observations exist for the observed variable outside of a certain interval. In contrast, censored data are data samples where at least some explanatory variables exist for the observed variable within a certain interval, and both are incomplete data sets, but censored data do not affect the size of the analyzed sample. In contrast, truncated data generally reduce the size of the sample. In this paper, the efficiency values obtained using the DEA model are restricted dependent variables between $[0,1]$, so this paper will also use the Tobit model to analyze the influencing factors.

The standard Tobit model is defined as:

$$y_i^* = \beta X_i + \mu_i, \mu_i \sim N(0, \sigma_{\mu_i}^2), i = 1, 2, \dots, n \quad (9)$$

where i denotes the i nd observation unit, y_i^* is the true sample value, X_i is the vector of outward-looking parameters of $K \times 1$, which denotes the vector of outward-looking factors of the analyzed influences, and μ is the random disturbance term obeying $N(0, \sigma_{\mu_i}^2)$ an independent identically distributed (IID) [20]. The restricted sample value y_i is then:

$$y_i = \begin{cases} y_i^*, & y_i^* > 0 \\ 0, & y_i^* \leq 0 \end{cases} \quad (10)$$

Since the sample dataset consists of (y_i^*, X_i) and $(0, X_i)$, Eqs. (9) and (10) are reviewing the regression analysis model. When the sample dataset consists of only (y_i^*, X_i) , it is truncated data.

Therefore, the conditional expectation of the truncated data is:

$$E(y_i | y_i > 0) = E(y_i^* | y_i^* > 0) = \beta X_i + E(\mu_i | \mu_i > -\beta X_i) \quad (11)$$

The conditional expectation of the review data is:

$$\begin{aligned} E(y_i | X_i) &= \text{Prob}(y_i = 0) \cdot 0 + \text{Prob}(y_i > 0 | X_i) \cdot E(y_i | y_i > 0, X_i) \\ &= \text{Prob}(\mu_i \leq -\beta X_i) \cdot 0 + \text{Prob}(\mu_i > -\beta X_i) \cdot E(y_i^* | X_i; \mu_i > -\beta X_i) \\ &= \text{Prob}(\mu_i > -\beta X_i) \cdot [\beta X_i + E(\mu_i | \mu_i > -\beta X_i)] \end{aligned} \quad (12)$$

Since μ obeys an independent homogeneous distribution of $N(0, \sigma_{\mu_i}^2)$, it follows:

$$\text{Prob}(\mu_i > -\beta X_i) = 1 - \Phi\left(\frac{-\beta X_i}{\sigma_{\mu_i}}\right) = \Phi\left(\frac{\beta X_i}{\sigma_{\mu_i}}\right) \quad (13)$$

$$E(\mu_i | \mu_i > -\beta X_i) = \sigma_{\mu_i} \left[\phi \left(\frac{\beta X_i}{\sigma_{\mu_i}} \right) / \Phi \left(\frac{\beta X_i}{\sigma_{\mu_i}} \right) \right] \quad (14)$$

where $\phi(\cdot), \Phi(\cdot)$ is the standard normal density function and the cumulative normal distribution function, respectively.

Therefore, the likelihood function L_1 for truncated data is:

$$L_1 = \prod_{y_i > 0} [Prob(y_i > 0 | X_i)]^{-1} f(y_i) \quad (15)$$

The likelihood function L_2 for the reviewed data is:

$$\begin{aligned} L_2 = & \left\{ \prod_{y_i=0} [Prob(y_i=0 | X_i)] \cdot \prod_{y_i>0} [Prob(y_i>0 | X_i)] \right\} \\ & \times \left\{ \prod_{y_i>0} [Prob(y_i>0 | X_i)]^{-1} f(y_i) \right\} = \prod_{y_i=0} [Prob(y_i=0 | X_i)] \prod_{y_i>0} f(y_i) \end{aligned} \quad (16)$$

Since μ obeys an independent homogeneous distribution of $N(0, \sigma_{\mu_i}^2)$, it follows:

$$f(y_i) = (2\pi)^{-\frac{1}{2}} \sigma_{\mu_i}^{-1} \exp\{-(1/2\sigma_{\mu_i}^2)(y_i - \beta X_i)^2\} \quad (17)$$

$$Prob(y_i = 0 | X_i) = \Phi(-\beta X_i / \sigma_{\mu_i}) = 1 - \Phi(\beta X_i / \sigma_{\mu_i}) \quad (18)$$

The great likelihood value θ' of parameter $\theta = (\beta, \sigma_{\mu_i})$ can be calculated through equations (15) and (16), i.e., the weighting coefficients β of each factor affecting the efficiency value can be determined.

3 Results and analysis

Hunan culture is a regional culture with strong local characteristics. Sports culture, as a branch of it, plays an important role in Hunan culture. The status of Hunan sports culture has been further enhanced due to the increasing frequency of sports culture exchanges in the world. The people of Hunan region have shown us the real meaning of sports culture with practical actions and proved to the world that Hunan sports culture is an outstanding representative in the history of human sports culture. This chapter takes Hunan sports culture as a research example, based on the evaluation of the efficiency of sports culture dissemination and related models given in the previous section, to provide reliable support for exploring the effective path of Hunan sports culture dissemination.

This paper chooses the development data of Hunan sports culture between 2012 and 2019 as the research example, and the original data comes from the annual report of Hunan Culture and Tourism Bureau, Hunan Provincial Statistical Yearbook, Hunan Sports Blue Book and the official website data of relevant Hunan sports and culture events.

3.1 Evaluation of the Communication Efficiency of Hunan Sports Culture

3.1.1 Efficiency of dissemination of Hunan sports culture

Based on the development data of Hunan sports culture between 2012 and 2019, combined with the DEA evaluation model given in the previous section, the DEAP software can be used to calculate the redundancy of cultural inputs and the insufficiency of outputs reflecting the distance and direction of each non-DEA effective decision-making unit to reach the DEA effective, and then analyze the problem of resource allocation of ineffective units. In this paper, we choose the primary indicators as the original inputs and the secondary indicators as the outputs to analyze the communication efficiency of sports culture in Hunan. In the DEA model, the dissemination efficiency of Hunan sports culture is decomposed into comprehensive efficiency, pure technical efficiency and scale efficiency, and the dissemination efficiency of Hunan sports culture between 2012 and 2019 is shown in Figure 2.

As can be seen from the figure, the comprehensive mean value of the communication efficiency of Hunan sports culture is 0.762. The mean values of pure technical efficiency and scale efficiency are 0.922 and 0.852 respectively, indicating that the inefficiency of the communication of Hunan sports culture mainly comes from the pure technical inefficiency of 0.078. The inefficiency from the scale efficiency of 0.148, which represents that the inefficiency of scale of communication of Hunan sports culture is the main reason of the overall communication of Hunan sports culture, i.e., the actual inefficiency of scale of communication is the main reason of the inefficiency of communication of Hunan sports culture. This means that the scale inefficiency is the main reason for the inefficiency of the overall dissemination of Hunan sports culture, i.e., the gap between the actual scale of Hunan sports culture dissemination and the optimal scale of Hunan sports culture dissemination is large. The decreasing trend of the overall efficiency of the dissemination of Hunan sports culture shows that, in order to improve the dissemination efficiency of Hunan sports culture, it is necessary to increase the investment in sports culture and to enhance the recognition of Hunan sports culture by the public through more diversified sports and cultural activities with Hunan characteristics. Moreover, by calculating its redundancy rate, it can be seen that in 2012~2019, the redundancy rate of Hunan sports culture in terms of cultural input was relatively high, and after a significant downward adjustment in 2014 and 2017, there is an upward trend in 2018~2019, and the average value of redundancy rate in eight years is 18.15%. It can be seen that the government of Hunan has increased its investment in Hunan sports culture to a certain extent, which aids in the dissemination and influence of Hunan sports culture.

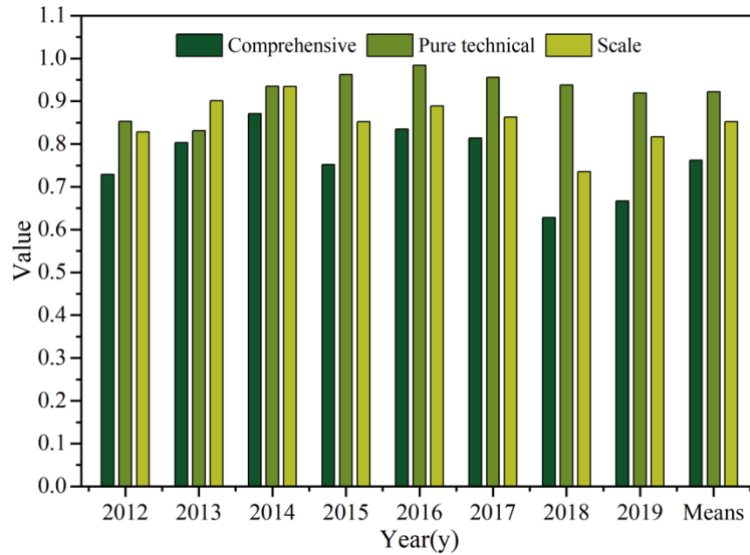


Figure 2. Communication efficiency of Huxiang sports culture

3.1.2 Redundancy in cultural communication outputs

Table 2 shows the output insufficiency rate of non-DEA effective units in the communication efficiency of Hunan sports culture. The evaluation index system of sports culture dissemination efficiency given in the previous section is reflected in the indicators represented by the data from A1 to D4. An analysis of the insufficient aspects of output shows that the redundancy of indicators A1 to A4 in the economic dimension is relatively low, and the sum of the mean redundancy rates of its four indicators is 58.075%, which is a relatively optimistic situation. In particular, cultural output (A2), as a measure of the output efficiency of the dissemination of Hunan sports culture, has the least input redundancy problem, indicating that the dissemination of output of Hunan sports culture has been more effective in recent years, and the masses are increasingly recognizing Hunan sports culture. The technical dimension is the primary representation of indicators with severe redundancy problems, as three out of the four indicators, C1-C4 have more than 25% redundancy. Under the spatial dimension, the output of spatial foundation (D1) is seriously insufficient, and its redundancy even reaches 90.36%, but its cultural resources (D2), cultural facilities (D3), and cultural landscapes (D4) are more important inputs to the efficiency of the dissemination of Huxiang sports culture, and the redundancy of the three is only 7.68%. This shows that in the process of spreading Hunan sports culture, Hunan culture can be effectively integrated with sports resources, and the improvement of infrastructure and cultural landscape promotes the development of Hunan sports culture. Moreover, there are large redundancies in economic, social, technological and spatial bases in all dimensions, which should be the focus of the future dissemination of Hunan sports culture, and the activation of all basic resources can improve the efficiency of the dissemination of Hunan sports culture in a comprehensive way.

Table 2. Percentage of output slack surplus of Huxiang sports culture

	2012	2013	2014	2015	2016	2017	2018	2019	Means
A1	50.75	60.41	63.37	48.96	42.61	55.93	38.31	42.05	50.29
A2	3.51	4.63	1.51	2.32	0.17	1.65	1.09	0.95	1.98
A3	2.35	2.25	4.17	4.62	3.25	2.79	3.46	3.42	3.29
A4	3.78	1.29	1.41	2.64	1.83	2.78	2.45	3.89	2.51
B1	62.64	51.94	41.97	23.83	21.65	47.83	49.47	37.64	42.12
B2	8.31	16.28	11.36	8.94	3.37	9.52	16.45	19.34	11.69
B3	6.49	10.09	14.52	3.43	1.59	9.24	2.61	6.11	6.76
B4	4.53	4.17	1.04	2.65	3.58	2.49	1.12	4.38	2.99
C1	42.35	20.57	49.54	78.35	62.17	45.65	27.49	33.46	44.95
C2	15.12	16.31	2.49	20.41	3.46	2.43	12.74	15.39	11.04
C3	48.27	20.39	31.42	25.51	35.17	34.63	20.65	23.04	29.89
C4	12.35	13.14	16.82	16.63	33.52	40.47	50.26	17.46	25.08
D1	95.62	93.67	93.28	91.45	93.34	88.54	86.52	80.47	90.36
D2	1.15	2.96	3.15	1.94	1.87	3.46	4.48	4.32	2.92
D3	0.65	1.04	1.83	1.65	1.71	2.05	1.67	3.21	1.73
D4	1.32	2.63	0.67	5.42	6.68	2.54	3.06	1.94	3.03

3.2 Research Variables and Modeling

3.2.1 Variable selection and modeling

In this paper, we are going to use the Tobit model to empirically study the influencing factors of the dissemination of sports and culture in Hunan, choosing comprehensive efficiency (CRS), pure technical efficiency (VRS) and scale efficiency (SE) of the dissemination efficiency of sports and culture in Hunan as the explanatory variables, and choosing the economic inputs (EI), social inputs (SI), technical inputs (TI) and spatial inputs (RI) as the explanatory variables, as well as the economic inputs (EI), social inputs (SI), technical inputs (TI) and spatial inputs (RI). As explanatory variables. The cultural industry policy (CIP) is chosen as the mediating variable, and government support (GS), industry effect (IND), time effect (YEAR), and industry competition intensity (COMP) are chosen as the controlling variables to explore the relevant factors affecting the efficiency of the dissemination of sports and culture in Hunan.

The most central part of this paper is to use Tobit model to empirically measure the influencing factors of the dissemination efficiency of Hunan sports culture, and before conducting regression analysis, the Tobit econometric model is first set as:

$$HX_{i,t} = \delta_0 + \delta_1 CIP_{i,t} + \delta_2 EI_{i,t} + \delta_3 SI_{i,t} + \delta_4 TI_{i,t} + \delta_5 RI_{i,t} + \delta_6 Control_{i,t} + \varepsilon_{i,t} \quad (19)$$

$$CRS_{i,t} = \alpha_0 + \alpha_1 EI_{i,t} + \alpha_2 SI_{i,t} + \alpha_3 TI_{i,t} + \alpha_4 RI_{i,t} + \alpha_5 Control_{i,t} + \varepsilon_{i,t} \quad (20)$$

$$VRS_{i,t} = \beta_0 + \beta_1 EI_{i,t} + \beta_2 SI_{i,t} + \beta_3 TI_{i,t} + \beta_4 RI_{i,t} + \beta_5 Control_{i,t} + \varepsilon_{i,t} \quad (21)$$

$$SE_{i,t} = \gamma_0 + \gamma_1 EI_{i,t} + \gamma_2 SI_{i,t} + \gamma_3 TI_{i,t} + \gamma_4 RI_{i,t} + \gamma_5 Control_{i,t} + \varepsilon_{i,t} \quad (22)$$

In the above equation, $HX_{i,t}$ represents the dissemination efficiency of Hunan sports culture, $CIP_{i,t}$ is the cultural industry policy, $CRS_{i,t}$ represents the technical efficiency, $VRS_{i,t}$ represents the pure technical efficiency, $SE_{i,t}$ represents the scale efficiency, $Control_{i,t}$ is each control variable, $\alpha_i, \beta_i, \gamma_i, \delta_i$ is each regression coefficient, and $\varepsilon_{i,t}$ is the random perturbation term.

Selecting the development data of Hunan sports culture from 2012 to 2019, collecting and organizing each decision-making unit in the evaluation system of dissemination efficiency of Hunan sports culture, and finally obtaining 200 sets of effective sample data, Table 3 gives the descriptive statistical results of the data of each variable of input and output of Hunan sports culture. From the data distribution, it can be seen that the absolute value of the kurtosis of each variable is less than 2, belonging to the thick-tailed distribution, which is flatter than the normal distribution. The skewness of each variable representing technical input, government support, industry effect and industry competition intensity is less than 0, which is a typical right-skewed distribution, indicating that the data distribution is not uniform for the dissemination efficiency of Hunan sports culture.

Table 3. Descriptive statistical results of the variables

Variable	Min	Max	Means	Kurtosis	Skewness
CIP	0.249	2.768	1.024	0.262	0.116
EI	0.538	3.114	0.996	1.823	1.783
SI	0.441	2.881	1.178	1.121	2.761
TI	0.265	3.152	0.863	0.524	-0.429
RI	0.337	1.859	0.542	-0.337	0.282
GS	0.542	2.607	1.119	0.838	-0.714
IND	0.214	3.026	1.431	-1.152	-0.128
COMP	0.525	1.536	0.607	1.419	-0.065

3.2.2 Correlation test of variables

Correlation analysis is a common statistical method used to examine whether there is a linear relationship between two variables, i.e., to examine whether when one variable changes, the other variable will change. The scientific validity of regression analysis results will be significantly affected by a strong linear correlation between the independent variables in a linear regression model. In this paper, Pearson's correlation coefficient is chosen as the evaluation index, which indicates a positive correlation between $[0,1]$ and a negative correlation between $[-1,0]$, and the closer the value is to 1, the more significant the correlation is. The correlation test is conducted for each independent variable, and the results are shown in Table 4.

In the correlation test results, each variable is positively correlated with each other, and the correlation coefficient between most of the variables is less than 0.7, which can be considered that there is no typical linear correlation between the variables. Only the correlation coefficient of the two variables of cultural industry policy and economic input and government support exceeds 0.7, which needs to be handled carefully in the subsequent analysis of the two variables and parameter estimation in order to avoid the impact of the data brought about by the high correlation between the two.

Table 4. Test of the correlation of the variables

Variable	CIP	EI	SI	TI	RI	GS	IND	COMP
CIP	1	-	-	-	-	-	-	-
EI	0.716	1	-	-	-	-	-	-
SI	0.639	0.535	1	-	-	-	-	-
TI	0.421	0.798	0.524	1	-	-	-	-
RI	0.347	0.633	0.382	0.545	1	-	-	-
GS	0.715	0.082	0.491	0.326	0.468	1	-	-
IND	0.502	0.476	0.505	0.437	0.375	0.492	1	-
COMP	0.338	0.671	0.648	0.383	0.589	0.657	0.446	1

3.3 Tobit regressions and mediation effects

3.3.1 Tobit regression results and analysis

In this paper, Tobit regression analysis is carried out with the help of software Eviews. According to equations (20), (21) and (22), the comprehensive efficiency, pure technical efficiency and scale efficiency of the dissemination efficiency of Huxiang sports and culture are taken as dependent variables, respectively, and regression analysis is carried out using Tobit model. Table 5 shows the Tobit regression results of comprehensive efficiency, pure technical efficiency and scale efficiency, respectively.

In the comprehensive efficiency model of the dissemination of Hunan sports and culture, economic input, social input, technological input and spatial input all show strong significance at the 1% level, among which the correlation coefficient of technological input reaches 0.665, which indicates that for every 1% increase in technological input of the dissemination of Hunan sports and culture, the efficiency of the dissemination of Hunan sports and culture will be increased by 0.665 percentage points. Moreover, government support and industry effect also have a greater impact on the comprehensive efficiency of the dissemination of Hunan sports culture, and their correlation coefficients reach 0.556 and 0.627, respectively. In order to effectively improve the dissemination efficiency of Hunan sports culture, it is necessary to further enhance the support of the government, and to increase the influence of Hunan sports culture under the effect of the industry.

In the pure technical efficiency model of the dissemination of Hunan sports culture, the significance of the four dimensions is the same as that of the comprehensive efficiency model, in which the social and spatial inputs have a stronger influence, with similar correlation coefficients of 0.447 and 0.445, respectively. In addition to this, the time effect has a stronger relevance to the dissemination of Hunan sports culture, with a correlation coefficient of 0.492, which means that pure technical efficiency can cultivate a more suitable culture through time. Efficiency can cultivate the relevant talents more in line with the dissemination of Hunan sports culture through time, providing the talent base for promoting the dissemination of Hunan sports culture and further optimizing the structure of Hunan sports culture dissemination talents.

In the scale efficiency model of Hunan sports culture communication, all variables are significantly correlated at the 1% level, among which the correlation of technical input is the strongest and reaches 0.613, and the R² fitting value of the model after adjustment is 0.605, which suggests that the scale efficiency of Hunan sports culture communication can explain 60.5% of the efficiency of the communication and that increasing the technical input and expanding space input to obtain a more

efficient communication can be achieved by increasing technical input and expanding space input to obtain a more efficient communication. Under the scale efficiency, we should increase the technical input of cultural communication and expand the spatial input in order to obtain more diversified communication paths of Hunan sports culture and expand the recognition of Hunan sports culture in the hearts of the public.

Table 5. Tobit Regression results and analysis

Variable	CRS Model	VRS Model	SE Model
EI	0.224***(0.265)	0.185***(0.237)	0.314***(1.017)
SI	0.007***(1.082)	0.447***(0.965)	0.182***(0.296)
TI	0.665***(0.193)	0.302***(1.429)	0.613***(1.025)
RI	0.143***(0.096)	0.445***(0.528)	0.525***(0.548)
GS	0.556***(0.354)	0.383***(0.473)	0.339***(1.037)
IND	0.627***(0.349)	0.525***(0.606)	0.426***(0.841)
YEAR	0.525***(2.604)	0.492***(1.985)	0.464***(0.339)
COMP	0.448***(2.223)	0.415***(2.042)	0.411***(1.942)
(Constant)	0.754***(2.261)	0.553***(2.184)	0.602***(1.453)
F	3.119	2.483	1.954
ΔR^2	0.526	0.549	0.605

3.3.2 Mediating effects of cultural industry policies

In addition to the economic, social, technological and spatial influences on the dissemination of Hunan sports culture, the implementation of central and local cultural industry policies has an impact on the efficiency of its dissemination. To verify the mediating effect of cultural policy on the dissemination of Hunan sports culture, this paper builds a Tobit model that is based on cultural industry policy. Table 6 shows the regression results of cultural industry policy and the effectiveness of distributing Huxiang sports culture. The central and local cultural industry policies have a direct impact on the models (1) and (2).

Although there is a positive correlation between the formulation of central cultural, industrial policy and the efficiency of Hunan sports culture dissemination, and the correlation is significant at the 10% level, the correlation coefficient is not strong, and the correlation coefficient is only 0.019. The formulation of central cultural industrial policy affects the economic, social, technological and spatial inputs to a certain extent, and thus indirectly affects the efficiency of sports culture dissemination in Hunan; that is to say, there is an intermediary effect of centralized cultural industrial policy and the efficiency of Hunan sports culture dissemination. The central cultural industry policy has an indirect impact on the dissemination of Hunan sports culture. The implementation of local cultural, and industrial policy has a strong impact on the efficiency of the dissemination of Hunan sports culture, and its correlation coefficient reaches 0.618. Local cultural and industrial policy relies on local characteristics, whether the Hunan region backs up Hunan sports culture, and whether the cultural and industrial policy developed in accordance with local conditions is more in line with the development of local culture. The development of local cultural industry policy highly promotes the economic, social, technological and spatial inputs so as to realize the high impact on the communication efficiency of Hunan sports culture.

Table 6. The intermediary effect of the cultural industry policy

Variable	NCIP Model (1)	LCIP Model (2)
HX	0.019*(0.667)	0.618*** (0.054)
EI	0.112** (0.358)	0.527*** (0.241)
SI	0.327** (0.209)	0.635*** (0.315)
TI	0.083* (1.172)	0.474*** (1.053)
RI	0.158** (0.331)	0.449*** (0.562)
GS	0.096*** (0.001)	0.482*** (2.108)
IND	0.252*** (1.245)	0.353*** (1.486)
YEAR	0.414*** (0.923)	0.521*** (0.807)
COMP	0.515*** (0.414)	0.496*** (0.529)
(Constant)	0.469*** (0.002)	0.472*** (0.014)
ΔR^2	0.165	0.357

4 Conclusion

This paper establishes the evaluation system of communication efficiency of sports culture based on the Bello SMCR communication model and empirically analyzes the factors affecting its communication efficiency by using the DEA evaluation method combined with the Tobit model. Furthermore, the conclusions are as follows:

- 1) The comprehensive mean value of the communication efficiency of Hunan sports culture is 0.762, and the mean value of the redundancy rate of Hunan sports culture on cultural inputs in eight years from 2012 to 2019 is 18.15%. There is a severe deficiency in the output of spatial basis (D1), and its redundancy is 90.36%. The efficiency of the dissemination of Hunan sports culture needs to emphasize the cultural input and technical input and to plan reasonably in the spatial dimension of cultural dissemination so as to enhance the public's understanding of Hunan sports culture.
- 2) The correlation coefficient of technical input in the comprehensive efficiency of Hunan sports and culture dissemination reaches 0.665, the influence of social input in pure technical efficiency is stronger, with a correlation coefficient of 0.447, and the correlation coefficient of technical input in the efficiency of scale is 0.613, which indicates that the efficiency of the dissemination of Hunan sports and culture pays more attention to the effective input of technology and social resources, and the adoption of technology to realize the diversified development of the dissemination channels of Hunan sports and culture. Diversification of sports culture dissemination channels.
- 3) Both central and local cultural industry policies have intermediary effects on the communication efficiency of Hunan sports culture, with correlation coefficients of 0.019 and 0.618, respectively, and the local cultural industry policies have more influence on the communication of Hunan sports culture. Clarifying their regional cultural characteristics is necessary for local governments to plan an effective path for the dissemination and development of their cultural industries.

Funding:

This research was supported by the project: Study on the influence of “Internet Plus” on college students’ sports lifestyle and its guidance.

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