Research and Analysis on coordination degree of nonlinear identification entropy coupling model based on regional economy, social environment and sports industry

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Abstract. In view of the coordinated development of regional economy, social environment and sports industry, this paper constructs a research index system of coordination degree, and puts forward a nonlinear identification entropy coupling of regional economy, social environment and sports industry. It takes Chongqing, Sichuan, Guizhou, Yunnan and Xizang as examples to analyze. A nonlinear identification entropy coupling model of regional economy, social environment and sports industry is established. Finally, through MATLAB simulation analysis, the results show that the nonlinear identification entropy coupling model identification method is suitable for the coordinated development of regional economy, social environment and sports industry. The simulation results verify the feasibility and effectiveness of GMM model identification method based on sports economic growth, and provide reference for the stable development of sports economy.

Keywords: Sports industry, nonlinear identification, entropy coupling model, coordination degree of social environment, research and analysis.

1. Introduction

In recent years, the research on the relationship among regional economy, social environment and sports industry has become a hot topic for many domestic scholars, and most of them mainly focus on the relationship between the two [1]. However, there is little research on the relationship among regional economy, social environment and sports industry, especially the coordination degree, which mainly focuses on the comparative study of the external environment of sports industry [2-4]. To explore the coordination degree of regional economy, social environment and sports industry [5-6], it has a certain decision support role for local government departments to formulate relevant development policies, and has certain reference significance to promote the coordinated development of regional economy, social environment and sports industry [7-8].

Based on the exploratory factor analysis of the expected indicators affecting sports economic growth [9-10], this paper empirically analyzes the influence of various factors on sports economic
growth with the help of GMM model, so as to provide reference for the stable development of sports economy [11-13].

In this paper, a nonlinear identification entropy coupling between regional economy, social environment and sports industry is proposed, and five provinces in Southwest China, Chongqing, Sichuan, Guizhou, Yunnan and Tibet are taken as examples for analysis. A nonlinear identification entropy coupling model of regional economy, social environment and sports industry is established. Finally, through MATLAB simulation analysis, the results show that the nonlinear identification entropy coupling model identification method is suitable for the coordinated development of regional economy, social environment and sports industry. The simulation results verify the feasibility and effectiveness of GMM model identification method based on sports economic growth, and provide reference for the stable development of sports economy.

2. Sports economic growth of GMM model

This paper proposes a GMM model identification algorithm for sports economic growth, and establishes a GMM model model identification algorithm for sports economic growth. The actual system can be described by the following model:

$$
\varepsilon^o(k) = z^o_n(k) + \sum_{i=1}^{N} \beta_i \cdot z^o_m(k-i)
$$

(1)

In the formula: $u(k)$ and $z(k)$ are the input and output variables of the system; they are the additional noise of the system; and

$$
\varepsilon^o(k) - \varepsilon(k) = z^o_n(k) - \hat{z}_n(k) = z^o_n(k) - \hat{z}_m^o(k) = [\hat{\theta}^i(k) + \hat{\theta}^e(k)-\hat{\theta}^e(k-1)] \cdot \hat{h}_m^e(k)
$$

(2)

Let the order $n_a$ and $n_b$ be known and juxtaposed:

$$
\varepsilon(k) = \frac{\varepsilon^o(k)}{1 + h_m(k)(P+Q) \cdot \hat{h}_m(k)}
$$

(3)

In the formula: $\theta_e$ is the identification parameter of the $a_1, \ldots, a_{n_a} \cdot b_1, \ldots, b_{n_b}$ fixed model, and $z$ is the output of the corresponding $k$ th fixed model.

3. Nonlinear identification of GMM model for sports economic growth

Then the reference model can be written in the least square form:

$$
\varepsilon^o(k) = z(k) - \left[ \hat{\theta}_k^e(k-1) \right] \cdot \hat{h}_m(k) + \sum_{i=1}^{N} \beta_i \cdot \bar{z}_m^o(k-i)
$$

(4)

In the formula: $\bar{z}_m^o(k-i)$ is the system model parameter, $\hat{h}_m(k)$ is the estimated output of the model.

$\hat{\theta}_k^e(k-1)$ is colored noise, which can be expressed as:
\[ \tilde{z}_m(k) = -\alpha_0^T \cdot \tilde{z}_m(k) + \eta(k) \]  

(5)

For convenience, the case of \( n(k) = 0 \) is considered first. According to the theoretical analysis, the result is also applicable to the case of \( n(k) \neq 0 \).

\[
\begin{bmatrix} 
\tilde{z}_m(k) \\
\eta(k) 
\end{bmatrix} = 
\begin{bmatrix} 
\tilde{z}_m(k-1), \ldots, \tilde{z}_m(k-n) 
\end{bmatrix}^T 
\]

(6)

\[
\eta^+(k) = [\hat{\theta}(k) - \theta_o]^T \cdot h_m(k) 
\]

(7)

\[
\eta^+(k) = \sum_{i=0}^{1} \left[ \varphi_i^T(\varepsilon(l)) + \varphi_i^T(\varepsilon(l)) \right] + \tilde{\eta}^T \cdot h_m(k) 
\]

(8)

\[
\tilde{\eta} = -\theta_o + \hat{\theta}^i(-1), \quad \varepsilon = \tilde{z}_m + \beta^T \cdot \tilde{z}_m(k) 
\]

(9)

Define an adjustable vector of increasing dimension

\[
\eta^+(k) = \sum_{i=0}^{1} \left[ \varphi_i^T(\varepsilon(l)) + \varphi_i^T(\varepsilon(l)) \right] + \tilde{\eta}^T \cdot h_m(k) 
\]

(10)

In the formula: \( \eta^+(k) \) and \( h_m(k) \) are adjustable model input and output variables. Set

\[
\tilde{\eta} = -\theta_o + \hat{\theta}^i(-1) 
\]

(11)

This means that the coefficient color is also regarded as the identification parameter. At the same time, Equations (3) and (4) respectively use the following formula

\[
\beta = \left[ \beta_1, \beta_2, \ldots, \beta_{n_z} \right]^T 
\]

(12)

Feedback system with input output variables:

\[
\begin{aligned}
\hat{\beta}(k) &= \hat{\beta}^i(k) + \hat{\beta}^p(k) \\
\tilde{z}_m(k) &= z(m) - \theta_e^T(k) \cdot \tilde{h}_m(k) \\
\tilde{Z}_m^0(k) &= z(k) - \left[ \hat{\theta}_e^i(k-1) \right]^T \cdot \tilde{h}_m(k)
\end{aligned}
\]

(13)

In the formula: \( \hat{\beta}^i(k) \) and \( \hat{\beta}^p(k) \) correspond to the results of integral and proportional operations respectively.

Using the formula (3)-(13) iteration, the model parameter estimate can be obtained.
4. Experimental analysis and research

A nonlinear identification entropy coupling model of regional economy, social environment and sports industry is established. Finally, through MATLAB simulation analysis, the results show that the nonlinear identification entropy coupling model identification method is suitable for the coordinated development of regional economy, social environment and sports industry.

Through MATLAB simulation analysis, the results show that GMM model identification method is suitable for sports economic growth. Entropy coupling model for nonlinear identification 1, as is shown in Fig.1.

![Fig. 1 Entropy coupling model for nonlinear identification 1.](image1)

Entropy coupling model for nonlinear identification 2, as is shown in Fig.2.

![Fig.2 Entropy coupling model for nonlinear identification 2.](image2)

Through, through MATLAB simulation analysis, the results show that GMM model identification method is suitable for sports economic growth. Entropy coupling model for nonlinear identification 3 and Entropy coupling model for nonlinear identification 3, as is shown in Fig.3.
Fig. 3 Entropy coupling model for nonlinear identification 3.

Fig.4 Entropy coupling model for nonlinear identification 4.

In Figure 1, 2, 3, and 4, through MATLAB simulation analysis, the results show that the nonlinear identification entropy coupling model identification method is suitable for the coordinated development of regional economy, social environment and sports industry. The simulation results verify the feasibility and effectiveness of GMM model identification method based on sports economic growth, and provide reference for the stable development of sports economy.

5. Summary
In this paper, a nonlinear identification entropy coupling between regional economy, social environment and sports industry is proposed, and five provinces in Southwest China, Chongqing, Sichuan, Guizhou, Yunnan and Tibet are taken as examples for analysis. Finally, through MATLAB simulation analysis, the results show that the nonlinear identification entropy coupling model identification method is suitable for the coordinated development of regional economy, social environment and sports industry. The simulation results verify the feasibility and effectiveness of GMM model identification method based on sports economic growth, and provide reference for the stable development of sports economy.
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