

Application of optimized PLS-SEM measurement model and empirical research on Chinese cultural and creative industries competitive formation mechanism

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Abstract

Based on reviewing the PLS-SEM measure model, and summarizing the theory and reference of other scholars, the PLS-SEM measure model is optimized, in order to contain many latent variables and relatively scientific operations. At the same time, we make comments on the framework of industrial competitiveness referring to diamond model theory. Summarize the factors affecting the competitiveness of cultural and creative industry and measurement standard, and construct the framework of mechanism model for the formation of the cultural and creative industries' competitiveness. Using PLS-SEM measurement optimization model's 62 sets of data on Chinese provinces' cultural and creative industry in 2011 and 2012 to do the empirical analysis. The final optimization model is verified rationally. The study finds that the ability of sustainable development, capacity requirement, the government support and the overall innovation capability influence on cultural and creative industries' competitive strength are the most important keys.

Keywords: PLS-SEM measurement model, application of optimization, competitiveness of cultural and creative industry, formation mechanism, empirical study

1 Introduction

PLS-SEM measure model is the PLS regression analysis and SEM modelling organically, commonly used to solve the latent variable and multi correlation problem in SEM. PLS-SEM is a good application of PLS regression, and the application scope of the SEM wide. But PLS-SEM requires small sample data, which can achieve small sample modelling, but the fitting result reduces accuracy. Therefore, the PLS-SEM measure model are optimized in this paper, which can contain many latent variables and fitting relative science, at the same time, applying the PLS-SEM model to the cultural and creative industries make its application in the prediction of LISREL better than the traditional way. The empirical research, cultural and creative industries are important parts of the competitiveness of one country or one region. How to improve the competitiveness of the cultural and creative industries has become the focus of attention. In China, the cultural and creative industries have not yet become a pillar Industry of the country, from all regions, the cultural and creative industry structure are not rational. Regional differences in the configuration of the great cultural resources, the competitiveness of the cultural and creative industries in terms of the level of nations have become weak from among regional perspective. China's "Twelfth Five-Year Plan" to promote cultural and creative industry has become a pillar industry of the national economy, cultural and creative industries to enhance the overall strength and competitiveness. Therefore, how to enhance the Chinese competitiveness of cultural and creative industries is the key to the sustainable development of cultural and creative

industries [1]. Theoretically, the cultural and creative industries solve the competitiveness problem, the distinction depends on the competitiveness. And competition effectively measures the results, while the formation mechanism of cultural and creative industries need to competitiveness clear.

In this paper, we learn from Professor Porter Diamond Model thinking, based on a comprehensive variety of Hua Jian and other scholars to industrial competitiveness analysis of theoretical advantages, and cultural and creative industries are from its own characteristics, the formation of cultural and creative industries competitive analysis framework; and based on the theory of using PLS-SEM measure model application of optimization, it constructed competitiveness of China's cultural and creative industries formation mechanism model and empirical analysis.

2 Cultural and creative industries competitiveness literature review and analysis

2.1 CULTURAL AND CREATIVE INDUSTRY COMPETITIVENESS

"Competitiveness" content contained in the broader scope of this concept, more levels, can be divided into micro, meso and macro competitiveness. Cultural and creative industries competitiveness belong to the concept of meso competitive category (Figure 1), its meaning is the provider of cultural goods and services through the development of cultural resources and it ultimately acquire the ability to profit [2].

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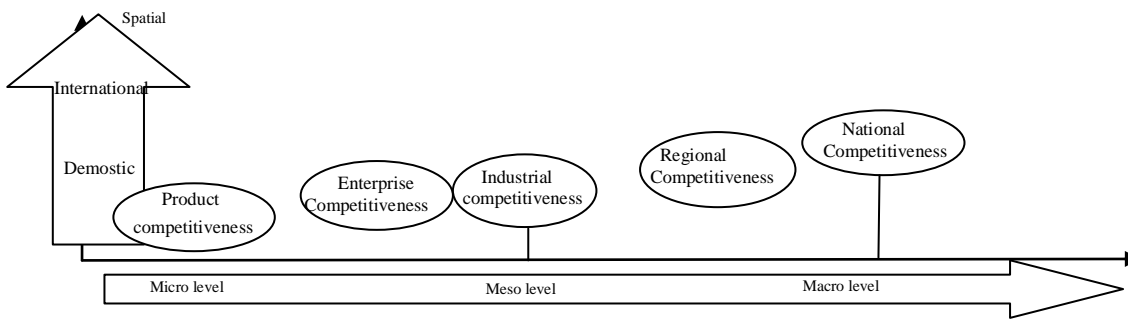


FIGURE 1 Space and the level of industrial competitiveness

2.2 RESEARCH STATUS OF CULTURAL AND CREATIVE INDUSTRIES COMPETITIVE ASSESSMENT SYSTEM

In the study of the cultural and creative industry competitiveness evaluation system, the Porter "diamond model" to build a far-reaching industrial competitiveness framework, many Chinese scholars are based on the "diamond model" of the basic theory, combined with Chinese current situation propose a new evaluation system. In addition, there are many scholars from different angles start to explain and build their own evaluation system. This paper selects a representative portion of research evaluation system aspects of the comparative analysis, and has conducted focus collated.

Qishu Yu, Yin Guojun, Li Yichun et al study mainly Potter "diamond model" evaluation system [3,4], LiGao Ye in "diamond model" is based on improved, finishing the traditional five systems which is divided into three modules: core competitiveness module, based competitiveness module and soft environment competitiveness module [5]. In addition to Porter "diamond model" based on the outside, Hua Jian, Zhao Yanyun, Xu Ping, DengYan Wen other scholars divided the competitiveness level region based on respect, summarized the various core competencies in cultural and creative industries, and on this basis, put forward different competitive structure model. LiXue Ru focused on the organization's internal point of view, on the basis of VRIO model, to build a new regional cultural and creative industries competitive assessment system that effectively highlights the characteristics of the development potential of innovative and scarcity of cultural and creative industries [6]. In summary Chinese scholars research results in the cultural and creative industry competitiveness evaluation system can be found, scholars generally believe that sustainable development capacity, demand capability, overall innovation capability, production factors, government support and the development of related industries constitute the competitive advantage of cultural and creative industries.

2.3 RESEARCH STATUS OF CULTURAL AND CREATIVE INDUSTRIES COMPETITIVE INTENSITY MEASURE

Academia for "competitiveness" has not yet formed a unified measure of understanding. Professor Michael E Porter

[7], Professor Paul Krugman [8], IMD [9], WEF and OECD different from each other and have been given a certain influence and representation definition. After summarizing, we can draw competitive connotation including the following four aspects: increasing market share, creating wealth, sustainable development and efficient usage of resources. Between the four objectives have some relevance, create wealth can be used to increase market share and efficient use of resources to indicate that:

$$z_2 = f(z_1, z_4). \tag{1}$$

After literature review we found that, increasing market share, creating wealth, sustainable development and efficient usage of resources covered most current achievements, on which most scholars and research institutions do research (As shown in Table 1).

TABLE 1 Study on the target concept based on the definition of competitiveness

Researchers	Study	Research objectives
Porter	Countries, industries, businesses	Improve resource utilization
OECD	Countries, industries, businesses	Sustainable development, efficient use of resources
IMD	Enterprise, national	Create wealth
Qishu Yu	Industry, business	Effective use of wealth creation, sustainable development, resource
WEF	Enterprises	Increase market share
AIC	Industry	Increase market share and create wealth
UNCTAD	Enterprises	Effective use to increase market share, sustainable development,
Hua Jian	Industry	Increase market share, create wealth and sustainable development

2.4 ESTABLISHMENT OF CULTURAL AND CREATIVE INDUSTRIES COMPETITIVE ANALYSIS INDICATORS

The main driving force behind the development of cultural and creative industries is the demand of the national economy for the cultural and creative products, the people's living standards improve, at the same time meet the material needs, spiritual and cultural needs of increasingly strong, the greater the demand, the scale of the cultural and creative industries larger. Demand for increased speed in a certain sense about the speed of the development of cul-

tural and creative industries. Therefore, an area for cultural and creative product demand is one of the factors stimulating the development of cultural and creative industries. In addition, the capacity for sustainable development, the overall innovation capability, production factors, government support and the development of related industries, are also significantly influenced the development of the region's cultural and creative industries.

According to the characteristics of cultural and creative industries, on the basis of the interpretation of research methods, combined with the consolidation analysis of relevant literature, according to the comprehensiveness, feasibility, simplicity and hierarchy principles, application and extend scholars analyzed the theoretical framework of industrial competitiveness to the cultural and creative industries, building a system of influencing factors competitiveness of Chinese culture and creative industries, as shown in Table 2.

TABLE 2 Influence factors of cultural and creative industry competitiveness index

Index Classification	Latent Variables	Specific observations
Cultural and creative industries competitive results metrics	Cultural and creative industry competitiveness	Regional cultural and creative industries accounted for the country's cultural and creative industry was the proportion Capital profit cultural and creative industries
Cultural and creative industry competitiveness index formation mechanism	Capacity for sustainable development	Cultural and creative industries accounted in GDP Cultural and creative industries profit growth GDP per capita in the region
	Demand capability	Urban per capita disposable income Per capita consumption expenditure Proportion of total consumption expenditure per capita cultural spending
	Overall innovation capability	Number of cultural and creative enterprises to obtain intellectual property rights Cultural and creative industries into the R & D expenses to total R & D funding share Technological progress contribution rate cultural and creative industries
	Production factors	The number of national cultural industry Has the world's natural heritage and cultural heritage of the number The artist has a number of people in senior staff scientist
	Government support	Government deficit / surplus of GDP accounted for Local UNESCO utility costs per capita The number of government policies and regulations promulgated and implemented the cultural industries
	Development of related industries	Gross tertiary industry production Travel, entertainment, dining and other related industries for the development of cultural and creative industries pulling rate The ratio of foreign tourists and the local population

3 PLS-sem introduction

3.1 THE PRINCIPLE OF PLS-SEM

SEM namely structural equation model is based on the existing causal theory, with its corresponding system of linear equations that represents a causal theory of statistical analysis techniques [10]. Commonly used modelling methods are mainly two, respectively, based on analysis of covariance matrix, namely LISREL or AMOS methods and PLS analysis methods, namely partial least square method. PLS method is iterative principal component analysis and multiple regression analysis combined estimate. Due to normality, the sample size and model data to identify conditions, such as LISREL or AMOS no less stringent, are called "soft modelling" approach [11]. The basic theory of PLS modelling is the "Predictor Specification", i.e.

$$y = a + Bx + \varepsilon,$$

therefore $\hat{y} = E(y|x) = \hat{a} + \hat{B}x,$

conditions $E(\varepsilon) = 0, Cov(x, \varepsilon) = 0.$

Typically, PLS evaluation algorithms are mainly two, namely Blindfolding and Bootstrap. Specific to this article, use Visual PLS software Bootstrap algorithm path analysis between hypothesis testing and latent variable.

PLS-SEM consists of two parts: The first is the measurement model, which describes the relationship between the significant variables and latent variables; followed by the structural model (SEM), which describes the relationship between latent variables [12].

Set up a structural equation model group was composed of J variables (in this study, $J=7$) form, each containing p_i variables, then each set of significant variables can be expressed as

$$X_j = (x_{j1}, x_{j2}, \dots, x_{jp_j}) \quad (j = 1, 2, \dots, J) \quad (\text{in this study,}$$

$$X_1 = (x_{11}, x_{12}); \quad X_2 = (x_{21}, x_{22}, x_{23}); \quad X_3 = (x_{31}, x_{32}, x_{33});$$

$$X_4 = (x_{41}, x_{42}, x_{43}); \quad X_5 = (x_{51}, x_{52}, x_{53});$$

$$X_6 = (x_{61}, x_{62}, x_{63}); \quad X_7 = (x_{71}, x_{72}, x_{73}).$$

Usually assume that the $x_{jh} (j = 1, 2, \dots, J; h = 1, 2, \dots, p_j)$ variables are based on n (in this study $n=62$) in common observation point, and each of the variables are center. Significant variables in group X_j corresponding to the hidden variable ξ_j is a standard. In PLS-SEM, the measurement model constitutes formed between significant variable X_j and the corresponding latent variables ξ_j , constitutes the structural model between different latent variables ξ_j .

3.2 MEASUREMENT MODEL AND THE STRUCTURAL MODEL OF PLS-SEM

Each significant variable associated with latent variables only, the relationship between them can be obtained by a linear regression equation, i.e.

$$x_{jh} = \lambda_{jh} \xi_j + \varepsilon_{jh},$$

where ε_{jh} is the random error term, the average value is 0, and ξ_j is not associated with latent variables. Requests a set of latent variables is the only variable to reflect, to satisfy such a condition is considered to be the only significant variable dimension, the test methods are the principal component analysis of variables, *Cronbach's* α , and *Dillon-Goldstein's* ρ .

SEM describes the causal relationship between different latent variables ξ_j , form

$$\xi_j = \sum_{i \neq j} \beta_{ji} \xi_i + \zeta_j,$$

among them, ζ_j is the random error term, and the average value was 0, and was not associated with ξ_j .

In order to obtain the parameters in the above model estimation, can be carried out from two aspects. One is the latent variables ξ_j by linear combination of significant variable X_{jh} to estimate, this estimate is denoted as Y_j , i.e.

$$Y_j = \left(\sum_{h=1}^{p_j} w_{jh} x_{jh} \right)^* = (X_j w_j)^*, \tag{2}$$

wherein, w_j is the number of weight vectors, and the asterisk indicates the estimated amount of standardized.

On the other hand, latent variables can be estimated by other latent variables associated with it, estimates so obtained is called internal estimator, denoted as Z_j , i.e.

$$Z_j = \left(\sum_{i=\beta_{ji} \neq 0} e_{ji} Y_i \right)^*, \tag{3}$$

among them, e_{ji} is the internal weights, the calculation method of e_{ji} for

$$e_{ji} = \text{sign}(r(Y_j, Y_i)) = \begin{cases} 1, & r(Y_j, Y_i) > 0, \\ -1, & r(Y_j, Y_i) < 0, \\ 0, & r(Y_j, Y_i) = 0. \end{cases}$$

In the Equation, *sign* function of the symbol; $r(Y_j, Y_i)$ represents the estimated amount of the external correlation coefficients Y_j and Y_i .

For the calculation of the weight vector w_j , *Wold* presents a calculation method that the weight vector w_j is the correlation coefficient variable X_j and Z_j , then:

$$w_j = \frac{1}{n} X_j^T Z_j. \tag{4}$$

For the standardization of the vector, w_j is actually Z_j to X_j doing weights on partial least squares of the first principal component.

In summary, PLS-SEM analysis using an iterative algorithm to calculate the latent variables, and finally according to the estimated value of latent variables, calculate the measurement model and the structural model (SEM), the specific calculation steps are as follows:

Step 1. Set the initial value of the vector Y_j is equal to x_{j1} .

Step 2. Based on Equation 3 to calculate the estimated value of Z_j .

Step 3. Based on the estimated value of Z_j by Equation (4) to calculate the weight vector w_j .

Step 4. According to the calculated w_j , using Equation (2) to calculate the new re- Y_j . Then return to Step 2 until the calculation converges to finally get Y_j to the latent variables ξ_j as the estimated value of $\hat{\xi}_j$.

Step 5. According get $\hat{\xi}_j$, a linear regression model using ordinary least squares algorithm to estimate the measurement model and structural model parameters λ_{jh} , and β_{ji} .

4 An empirical study on the formation mechanism of competitiveness of cultural creative industry based on PLS-SEM

4.1 THE RESEARCH HYPOTHESIS AND DATA COLLECTION

According to Western scholars of cultural and creative industries competitive factors and measure the results of the research results, combined with the cultural and creative industries competitive analysis indicators constructed in this study, put forward the following hypothesis, as shown in Figure 2.

H1: sustainable development ability has a positive impact on competitiveness of cultural creative industry. H2: government support has positive effect on the capacity of sustainable development. H3: government support has positive effect on the overall innovation capability. H4: whole innovation ability has a positive impact on competitiveness of cultural creative industry. H5: related Industrial development has a positive impact on competitiveness of cultural creative industry. H6: demand has a positive impact on the development of related industries. H7: demand ability has a positive on the competitiveness of cultural and creative industries. H8: factor of production has positive effect on the competitiveness of cultural and creative industries.

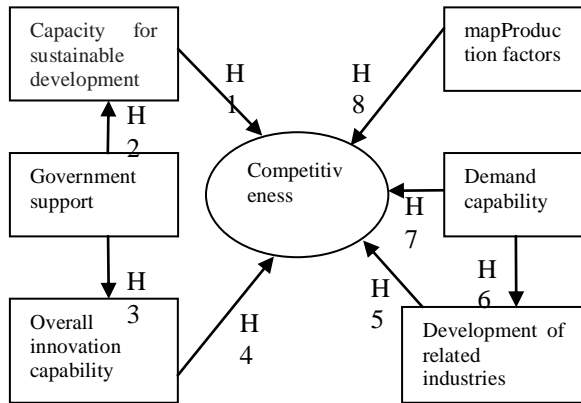


FIGURE 2 Influence factor research hypothesis framework competitiveness of Cultural Creative Industry

Data collection and collation according to table to establish cultural and creative industry competitiveness influencing factors. Data from the "China Statistical Yearbook 2012", "2012 China Statistical Yearbook of Cultural Heritage" and "China Statistical Yearbook 2011", "2011 China Statistical Yearbook of Cultural Heritage" in our various provinces and autonomous regions on (including municipalities) cultural and creative industries the basic situation of 62 groups described the basic data.

4.2 LATENT VARIABLE RELIABILITY ANALYSIS

Reliability tests aspects of internal consistency reliability and synthetic reliability. Internal consistency reliability, usually used as a measure of *Cronbach's alpha*, generally require α value greater than 0.7 (some scholars believe to be greater than 0.6), the present study six latent variables have α value of more than 0.7 (α value although competitive less than 0.7 but also reached a basic requirement). Synthetic reliability, usually *CR* coefficient as a measure, generally require more than 0.7.

$$CR = \frac{\left(\sum_{h=1}^{p_j} \lambda_{jh}\right)^2}{\left(\sum_{h=1}^{p_j} \lambda_{jh}\right)^2 + \sum_{h=1}^{p_j} \theta_{jh}^2}, \tag{5}$$

among them, λ_{jh} for j latent variables in the h significant variables load, θ_{jh} for j latent variables in the h variables measurement error. This paper uses the 7 latent variables of α are up to the standard. Specific numerical. Table 3.1 and Table 3.2

TABLE 3.1 Reliability analysis of latent variable cronbach'a coefficient

Variable reliability	Competitive ness	Capacity for sustainable development	Demand capability	Overall innovation capability
<i>Cronbach' alpha</i>	0.691	0.840	0.765	0.773
<i>CR</i>	0.803	0.861	0.781	0.817

TABLE 3.2 Reliability analysis of latent variable cronbach'a coefficient

Variable reliability	Production factors	Government support	Development of related industries
<i>Cronbach' alpha</i>	0.855	0.710	0.771
<i>CR</i>	0.870	0.812	0.801

4.3 DISCRIMINANT VALIDITY AND CONVERGENT VALIDITY TEST

Discriminant validity, degree of difference judge an idea from another. The absolute value of correlation coefficient using the square root of comparison of AVE with other latent variables: if greater than relationship, indicates that the discriminant validity, i.e. there is obvious difference between the numerical variables, as shown in Table 4.1 and Table 4.2. As can be seen, the numerical diagonal were square root AVE variables, are greater than the correlation coefficient between the diagonal of the variables with other variables, which shows the discriminant validity between concepts.

TABLE 4.1 Discriminant validity of latent variables

Discrimination concept	Competitive ness	Capacity for sustainable development	Demand capability	Overall Innovation capability
Competitiveness	0.807	0.785	0.744	0.787
Capacity for sustainable development	0.785	0.845	0.816	0.682
Demand capability	0.744	0.816	0.850	0.842
Overall Innovation capability	0.787	0.682	0.842	0.858
Production factors	0.442	0.803	0.619	0.761
Government support	0.516	0.334	0.752	0.594
Development of related industries	0.619	0.216	0.482	0.318

TABLE 4.2 Discriminant validity of latent variables

Discrimination concept	Production factors	Government support	Development of related industries
Competitiveness	0.442	0.516	0.619
Capacity for sustainable development	0.803	0.334	0.216
Demand capability	0.619	0.752	0.482
Overall Innovation capability	0.761	0.594	0.318
Production factors	0.841	0.391	0.806
Government support	0.391	0.817	0.219
Development of related industries	0.806	0.219	0.833

Convergent validity AVE value. FORNELL and other scholars have pointed out, the critical value of AVE value is 0.5. In this paper, PLS-SEM was also given the latent variables of AVE values, as show in Table 6.

$$AVE_j = \frac{\sum_{h=1}^{p_j} \lambda_{jh}^2}{\sum_{h=1}^{p_j} \lambda_{jh}^2 + \sum_{h=1}^{p_j} \theta_{jh}^2}, \tag{6}$$

among them, λ_{jh} for j latent variables in the h significant variables load, θ_{jh} for j latent variables in the h variables measurement error. It can be found from Table 6.1 and Table 6.2, all 7 latent variables, the values of AVE were greater than 0.5, AVE competitiveness of cultural creative industry of the minimum value reached 0.685, proved the existence of convergent validity.

TABLE 5.1 Latent variable convergent validity analysis table

Convergent validity	Competitiveness	Capacity for sustainable development	Demand capability	Overall innovation capability
AVE	0.685	0.797	0.766	0.747

TABLE 5.2 Latent variable convergent validity analysis table

Variable reliability	Production factors	Government support	Development of related industries
AVE	0.693	0.701	0.739

4.4 DATA ANALYSIS AND HYPOTHESIS VALIDATION

This paper mainly uses the Bootstrap algorithm with VISUAL-PLS software is for empirical test. PLS mainly through the $Rsq (R^2)$ to verify the model fitting degree and explanation, can be reflected in latent variables and exogenous latent variables explaining, and the prediction ability of the model, the interpretation of meaning and the traditional regression analysis R^2 in the same. As shown in Figure 3, R^2 all high, competitiveness of cultural creative industry is 0.751, the model has higher fitting degree and explanation. The results of hypothesis test, Figure 3 shows the standardized path coefficients and value t . Through the above can be seen, the 7 assumptions, values t are high, the minimum value of 2.012, reached the significant level of 0.05, all the model has been verified.

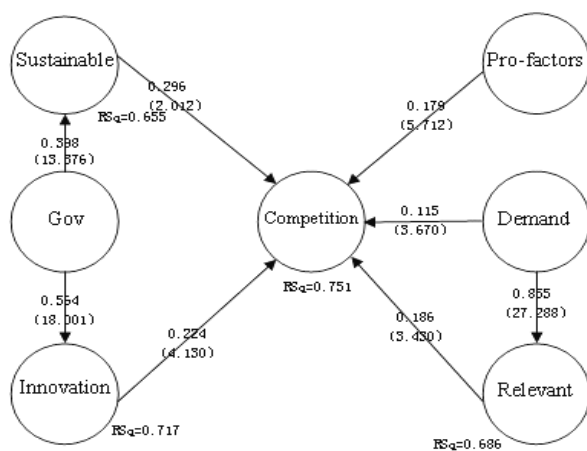


FIGURE 3 The formation mechanism of PLS-SEM path diagram of competitiveness of Cultural Industry

5 Conclusions

5.1 DIRECT EFFECT

The ability of sustainable development (0.296), the overall innovation capability (0.224), the development of related industries (0.186), the factors of production (0.179), (0.115) the demand ability of five latent variables have effect directly on the development of cultural and creative industry competitiveness. In this one, it directly affects the effect size in accordance with the above sequence. The ability of sustainable development is the biggest factor of all. This shows that exert a decisive influence of cultural and creative industry in one area of financial indicators and the development of local economy directly on the cultural creative industry competitiveness. Regional economic development level rapidly, both in the capital, or in the culture industry's top talent will play a strong attraction, which made a great influence on the competitiveness of cultural and creative industries. In addition, because the core value of cultural and creative industries are the cultural content and cultural content is original, which affects millions of people's psychological, raises society's widespread approval, fundamental elements, expands the area, and the overall innovation capability is second direct factors in the empirical study, it determines the value connotation important, thus affecting the competitiveness of cultural creative industry strength. The development of related industries and the factors of production two latent variables have directly influence on the cultural and creative industries competitive effect. Because of the particularity of the development of culture industry, culture industry organization efficiency is embodied in the industrial cluster, is a large number of interrelated cultural enterprises (such as film, advertising, publishing house), personal and relevant departments (such as university, industry associations, the service industry etc.) concentration and concentrated in certain geographical area within. A stable information network system and talent exchange system of the enterprises in cluster, this system can activate resources, and expand the exchange of information, enhance the flexibility, reduce transaction costs, it also can promote the idea generation [13]. The factors of production in the national parks of cultural industry index are a typical representation of cultural industry clusters. In addition, cultural and creative industry and the related industries, especially tourism, entertainment, and the rise and fall of the third industry also directly on the cultural and creative industry competitiveness of the size of lifting and pulling effect are very important. Demand ability seems to influence in the direct effect not before the five important factors, at the end, it shows so important to imagine not scholars demand factors in direct effects, which directly contributed to the cultural and creative industries competitive strength is less than the first several factors, however, demand ability of indirect effects on the competitiveness of cultural and creative industries are extremely important.

5.2 INDIRECT EFFECT

The first mentioned is the demand ability, in the indirect effect, effect directly affects the development of related industries up to 0.855, indicating the development of related industries, urban area needs in the cultural aspects of product has great influence on the development of the industry. Understandably, the local people in the future to meet the material needs, which is more close to tourism, entertainment, culture, leisure, and ultimately produce terminal effects on the competitiveness of cultural creative industry. If the direct effect and indirect effect of demand ability into the total effect the final effect on the cultural and creative industry competitiveness has reached as high as 0.274, ranking second in all factors, which is also verified by Professor Potter proposed in the diamond model of demand conditions are the second key factors for countries to industry. In addition, the support from the government does not have a direct effect on the competitiveness of cultural creative industry, but it is the sustainable development ability and the innovation ability of the whole produce direct effect. This is because the government support in the cultural sector and the formulation of laws and regulations seriously affects the cultural enter-

prise profit, internal innovation enthusiasm, and local cultural industry development strategy layout. From the micro view, the government promulgated the development of cultural industry policy is the favourable area to accelerate enterprise development, a solid foundation so as to enhance the regional competitiveness of the cultural industry. The final purpose of government support is to optimize the allocation of resources through the way of cultural Industry, has a direct effect on the sustainable development ability and the innovation ability of the whole, and thus indirectly to the cultural and creative industry competitiveness plays an important role in promoting.

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