

# Research on the Influence Path of Regional Logistics Capability on Regional Global Value Chain Status based on PLS-SEM

Han Su<sup>1,2</sup>

<sup>1</sup>School of Economics and Management, Xidian University, Xi'an 710126, China

<sup>2</sup>Shaanxi Soft Science Institute of Informatization and Digital Economy, Xi'an 710126, China

## Abstract

Each link in the global value chain is distributed in different regions of the world, so it needs strong regional logistics ability to adapt to and meet the needs of members in the chain and complex operation process. Therefore, it is an urgent practical problem to clarify the influence path of regional logistics capability on the status of global value chain. Based on the data of 31 provincial administrative regions in China from 2006 to 2016, the structural equation model of partial least squares method is established. It is found that regional logistics capability has a significant positive impact on the status of global value chain, and regional economy plays a part of intermediary effect in the process of influence. The government can promote the development of regional economy, improve the status of global value chain, and make the region more competitive in the development of economic globalization.

## Keywords

Regional logistics; Global value chain; Regional economy; Structural equation model.

## 1. INTRODUCTION

In economic globalization, in order to better meet the needs of consumers to maximize value, global cross enterprise network organizations effectively link and integrate the activities of design, development, manufacturing, marketing, consumption, after-sales service, recycling and other value links scattered in various countries, thus forming a global value chain [1]. With the rapid development of economic globalization, the competition of regional participation in the global value chain is becoming increasingly fierce, which also accelerates the process of regional cooperation and integration. It is an important way to realize national peace, development, cooperation and win-win situation to "cultivate a value chain and a big market with shared interests, work together to build a new global value chain, and promote the optimization and remodeling of the international division of labor system and global value chain" [2]. The global value chain has become a focus of developing countries represented by China [3]. The breadth and depth of China's participation in the global value chain has been continuously improved, and has become an important part of the global value chain of many industries. Regional embedment in global value chain, extensive participation in international division of labor and integration into global economic system are effective ways for local regions to achieve development [4].

In the case that international trade is increasingly dispersed through global value chain, good logistics capability is more important than ever, and the interruption of supply chain in a certain region may quickly spread to other countries and regions [5]. In the global value chain, production processes and processes are distributed in different regions of the world. The greater the demand among members of the chain, the more complex the operation process is,

the stronger the liquidity is needed to adapt to it, that is, the continuous improvement of regional logistics capability is needed. At present, China is accelerating the layout and construction of the national logistics hub, one of its purposes is to improve the overall competitiveness of the international supply chain, cultivate new advantages in international competition, and accelerate the advancement of Chinese industry to the middle and high end of the global value chain [6]. Therefore, it is an urgent problem to clarify the impact path of regional logistics capability on the status of global value chain.

Previous studies have explored the relationship between regional logistics capability and global value chain status. Like Adewole A et al.[7] focused on the global value chain and its importance to trade, discussed the strategic role of logistics and supply chain infrastructure in the development of Africa from the perspective of theoretical analysis; Lin Mengyao et al.[8] confirmed the impact of the quality of logistics facilities on China's participation in the global value chain; some scholars also discussed the relationship between regional logistics and export technology complexity from the perspective of foreign trade[9,10]. On the other hand, regional economy is a production complex produced by the interaction of internal factors and external conditions of economic development in a certain region [11]. On the relationship between regional economy and global value chain, Hong Jing [12] found that economies of scale effect is the key factor influencing emerging countries' participation in global value chain, and the level of economic development is an important factor promoting the competitiveness of participating in global value chain. Shen Yunzhu [13] found that the development of regional economy will promote the upgrading of regional industrial structure, improve the cooperation efficiency between regions, and further affect the participation and status of regions in the global value chain. This means that there may be a mediating effect between regional economy and regional logistics capability to enhance the status of global value chain. However, the existing research has not fully verified this hypothesis, which is not conducive to clear the specific impact path of regional logistics capability on the status of global value chain. Therefore, by constructing the structural equation model of partial least squares method, this paper deeply analyzes the influence path of regional logistics capability on the status of global value chain under the condition of regional economy as the intermediary variable, that is, how the regional logistics capability affects the status of global value chain, and whether there is intermediary effect in the process of regional economy influence. It is expected that this study can provide theoretical support and suggestions for the region to deepen its participation in the global value chain and improve its competitiveness in the global value chain from the perspective of improving logistics capability.

## **2. THEORETICAL BASIS AND HYPOTHESIS**

### **2.1. Regional Logistics Capability and Global Value Chain Status**

Combined with the definition of regional logistics capability [11,14-18], This paper holds that regional logistics capability refers to the ability of regional logistics suppliers to provide logistics support and logistics services for regional logistics demanders through effective and reasonable organization and utilization of various resources within their logistics system in a certain period of time. It also describes it from four aspects: infrastructure support capability, information system support capability, management and operation capability, and economic foundation promotion capability.

Each node of global value chain forms a complex network system, which depends on efficient logistics. Without the common development of modern logistics services and the promotion of logistics capabilities, we will not be able to enjoy many benefits brought by the global value chain [19-21]. According to the existing research, in order to realize the value of goods or services in the world, regions have formed a global cross enterprise network organization by

connecting production, sales, recycling and other processes, namely global value chain [1]. Global value chain involves cross regional raw material collection, transportation, production and distribution of semi-finished products and finished products, as well as consumption and recycling, so regional logistics capability is the most important. Regional logistics promotes the flow of products or services in the global value chain by completing collection, transportation, production, distribution and other activities, thus forming the result of regional participation in the global value chain. Therefore, the following hypotheses are put forward:

H1: regional logistics capability has a significant positive impact on the position of global value chain status;

H1a: infrastructure support capability has a significant positive impact on global value chain status;

H1b: information system support capability has a significant positive impact on the position of global value chain status;

H1c: management and operation capability has a significant positive impact on the position of global value chain status;

H1d: economic foundation promotion capability has a significant positive impact on the position of global value chain status.

## **2.2. Regional Logistics Capability and Regional Economy**

The regional logistics capability can provide the basic guarantee for the development of regional economy, so that the goods within the region can obtain higher efficiency in the process of diffusion and transmission. The development of logistics capability plays an important role in the development of regional economy. At the same time, it can gain profits through its own operation. The logistics within the region is an important economic industry within the region, and it is also conducive to the development of other industries. In the process of regional economic development, efficient, perfect and reasonable regional logistics system is the basic support of regional economic development [22]. Logistics capability can improve the efficiency and level of regional economic activities, promote the upgrading of regional industrial structure, and form the "growth pole" of regional economy [23]. Therefore, the following hypotheses are put forward:

H2: regional logistics capability has a significant positive impact on regional economy;

H2a: infrastructure support capability has a significant positive impact on regional economy;

H2b: information system support capability has a significant positive impact on regional economy;

H2c: management and operation capability has a significant positive impact on regional economy;

H2d: economic foundation promotion capability has a significant positive impact on regional economy.

## **2.3. Regional Economy and Global Value Chain Status**

The level of regional economic development is an important factor to promote the competitiveness of participating in the global value chain [12]. The formation of regional economy is the result of economic development with regional characteristics. From the perspective of globalization, it is the result of global economic division. Division of labor has resulted in a series of symbiotic phenomena: the increase of commercialization and marketization, the increase of trade dependence and complementarity, the increase of endogenous comparative interests, the increase of economic structure diversification, the increase of industrialization, the decrease of self-sufficiency rate, and the increase of market

concentration and market integration [23]. The continuous refinement of the division of labor objectively requires the improvement of the level of cooperation, and the logistics link is an important embodiment of the ability of cooperation. The continuous improvement of regional logistics capability promotes the upgrading of regional industrial structure, improves the cooperation efficiency between regions, and further affects the participation and status of regions in the global value chain.

Based on the theoretical basis and the purpose of this paper, this paper considers that regional economy has a mediating effect between regional logistics capability and global value chain status. Therefore, the following hypotheses are put forward:

H3: regional economy has a significant positive impact on global value chain status;

H4: regional economy plays an intermediary role in the relationship between regional logistics capability and global value chain status.

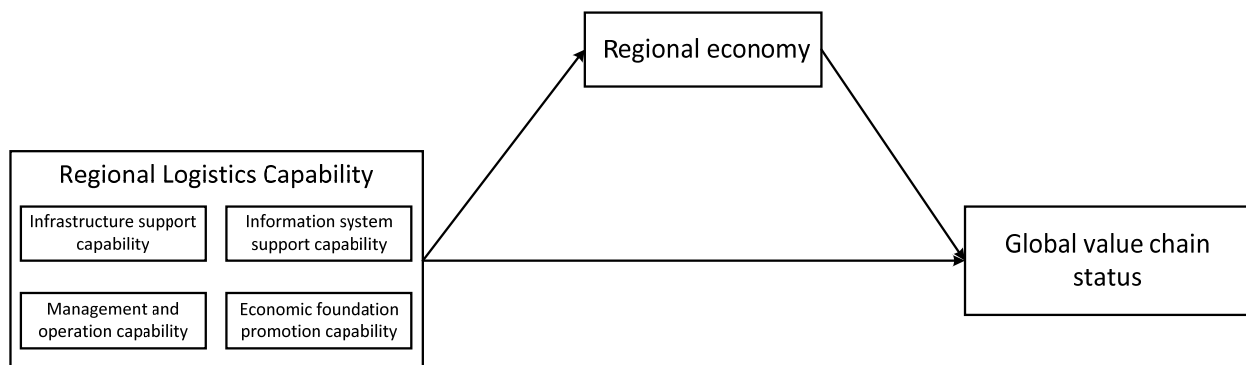
H4a: regional economy plays a mediating role in the relationship between infrastructure support capability and global value chain status;

H4b: regional economy plays a mediating role in the relationship between information system support capability and global value chain status;

H4c: regional economy plays a mediating role in the relationship between the management and operation capability and the status of global value chain;

H4d: regional economy plays a mediating role in the relationship between the economic foundation promotion capability and the status of global value chain.

Based on the above theoretical assumptions, the conceptual model as shown in Figure 1 is drawn to illustrate the relationship between each latent variable.



**Figure 1.** Conceptual Model

### 3. VARIABLE SELECTION

#### 3.1. Regional Logistics Capability

On the basis of three-tier quantitative index system established by Zhou Tai [15], combined with the actual social development, this paper improves the regional logistics capability index system. Infrastructure is the material basis to ensure the development of regional logistics activities, information system provides technical and network support for the development of logistics business, operation and management ability directly reflects the level of effective management of logistics activities, and economic foundation promotion ability provides the development basis for the operation of regional logistics. Therefore, this paper chooses infrastructure support capability, information system support capability, management and operation capability, economic foundation promotion capability as latent variables. Considering the representativeness and availability of data, 16 indexes such as road network density are

selected as observed variables. Four latent variables and sixteen observed variables constitute the evaluation index system of regional logistics capability.

### 3.2. Global Value Chain Status

Hausmann et al. [24] constructed the export technology complexity index to measure the technology content of a country's exports. In essence, the export technology complexity index at different levels represents the international competitiveness of a country, region, industry and product (enterprise) [25]. The higher the technical complexity of export products, the higher the added value, the faster the economic development, and the higher the position in the global value chain; on the contrary, countries/regions/industries with lower technical complexity of export products have lower competitiveness, lower added value, slower economic development, and lower position [26,27]. In this paper, the export technology complexity is regarded as the observed variable of the latent variable of global value chain status, and the calculation method of Hausmann et al.[24] is used for reference.

Firstly, the technical complexity (TSI) of each commodity is measured:

$$TSI_j = \sum_i \frac{x_{ij}/X_i}{\sum_i (x_{ij}/X_i)} Y_i \quad (1)$$

In the above formula, subscripts  $i$  and  $j$  represent provinces and export products respectively.  $TSI_j$  represents the technical complexity index of export commodity  $j$ ,  $X_{ij}$  is the export volume of  $j$  products of  $i$  province,  $X_i$  is the total export volume of  $i$  province,  $Y_i$  represents the per capita income level of  $i$  Province, which is generally replaced by per capita GDP. After calculating the export technical complexity of each product, the export technical complexity of each province is calculated. The calculation formula of inter provincial export technology complexity is as follows:

$$\sum S = \sum_j \frac{x_j}{X_i} TSI_j \quad (2)$$

### 3.3. Regional Economy

Based on the index system of Hu Zhongjun et al. [28], this paper mainly considers the economic benefits of regional economic development, and selects fiscal revenue and RMB savings deposits (year-end balance) of urban and rural residents in various regions as the observed variables of this latent variables from the government level and the individual level.

The definitions of latent variables and their corresponding observed variables are shown in Table 1.

## 4. RESEARCH DESIGN AND ANALYSIS

### 4.1. Research Methods

Structural equation model (SEM) is a statistical method to analyze the relationship between variables based on the covariance matrix of variables, also known as covariance structure analysis [29]. This paper uses this method to analyze the relationship between variables. The partial least squares (PLS) method does not need to set strict assumptions, does not require the distribution of samples, does not have strict requirements for the number of samples, and has better convergence, and is more suitable for prediction [30, 31]. Therefore, this paper

establishes the partial least squares structural equation model (PLS-SEM), and uses SmartPLS 3.0 software for data analysis and model validation.

**Table 1.** Variable definition

Latent variables	Observed variables	Variable symbol
Infrastructure support capability (X1)	GDP of transportation, storage and post industry / 100 million yuan	X <sub>11</sub>
	Proportion of infrastructure investment in logistics industry in total infrastructure investment	X <sub>12</sub>
	Road network density / (km/km <sup>2</sup> )	X <sub>13</sub>
	Per capita freight volume / (T / person)	X <sub>14</sub>
	Per capita freight turnover / (ton km / person)	X <sub>15</sub>
Information system support capability(X2)	Per capita business volume of Posts and telecommunications / (yuan / person)	X <sub>21</sub>
	Number of landlines per 10000 people / (households / 10000 people)	X <sub>22</sub>
	Number of mobile phones per 10000 people / (households / 10000 people)	X <sub>23</sub>
	Proportion of Internet users in total population	X <sub>24</sub>
Management and operation capability (X3)	Proportion of employees in logistics industry	X <sub>31</sub>
	Number of people with college degree or above per 10000 people / (person / 10000 people)	X <sub>32</sub>
	Education cost per capita / (yuan / person)	X <sub>33</sub>
	Credibility of regional logistics service providers	X <sub>34</sub>
Economic foundation promotion capability (X4)	Proportion of tertiary industry in GDP	X <sub>41</sub>
	Consumption level of residents in different regions / yuan	X <sub>42</sub>
	Total retail sales of social consumer goods / 100 million yuan	X <sub>43</sub>
Global value chain status	Export technology complexity	Y <sub>1</sub>
Regional economy (M)	financial revenue / 100 million yuan	M <sub>1</sub>
	RMB savings deposits of urban and rural residents in various regions (balance at the end of the year) / 100 million yuan	M <sub>2</sub>

#### 4.2. Data Collection and Statistical Analysis

The data scope of this paper is the data of 31 provinces and municipalities in China from 2006 to 2016, except Hong Kong, Macao and Taiwan. The data sources are China Statistical Yearbook, China Industrial statistical yearbook, etc. PLS-SEM includes two models: measurement model and structural model. Measurement model refers to the relationship between latent variables and their corresponding observed variables, and structural model refers to the relationship between different latent variables [30]. This paper will first analyze the reliability and validity of the measurement model, and then analyze the relationship between the variables in the structural model.

## (1) Reliability and validity of measurement model

Generally, the validity of structural equation model is analyzed by reliability and validity. As shown in Table 2, the Cronbach's alpha of each latent variable is greater than 0.7, and the combined validity (CR) is greater than 0.7, indicating that the scale has good reliability.

**Table 2.** Results of reliability and validity analysis

Latent variables	Cronbach's alpha	Combined validity(CR)	AVE
X1	0.820	0.872	0.579
X2	0.848	0.897	0.686
X3	0.794	0.867	0.622
X4	0.822	0.894	0.737
M	0.834	0.923	0.858
Y1	1.000	1.000	1.000

Validity is to examine the accuracy of measurement, including content validity and construct validity. Because the variable data in this paper mainly come from various statistical yearbooks, its content validity is high. Construct validity is divided into convergent validity and discriminant validity. The average extraction variance (AVE) of each latent variable in Table 2 is greater than 0.5, which indicates that the measurement model has good convergence validity. Discriminant validity can be evaluated by comparing the square root of AVE with the correlation coefficient. The square root of AVE value in Table 3 is greater than the correlation coefficient with other latent variables, which indicates that the discriminant validity is very good, and the possibility of collinearity among latent variables is very small.

**Table 3.** AVE square root and factor correlation coefficient

	X2	Y1	M	X1	X4	X3
X2	0.828					
Y1	0.661	1.000				
M	0.666	0.702	0.926			
X1	0.488	0.587	0.637	0.761		
X4	0.481	0.617	0.666	0.577	0.858	
X3	0.540	0.605	0.566	0.397	0.405	0.789

## (2) Structural model analysis

In this paper, the hypothesis of the structural model is first verified, then the path coefficient and significance are analyzed, and finally the path effect, explanatory power and predictive power of the model are analyzed.

## 1) Model hypothesis verification

According to bootstrapping algorithm, the data shown in Table 4 and Table 5 are obtained to analyze the relationship between latent variables and verify the model hypothesis. In bootstrapping, T value and P value are tested by repeated sampling of 5000 samples, and T value and P value are used to judge whether they are significant or not. In general, T value is greater than 1.96, P value is less than 0.05, which indicates that the result is significant and the hypothesis is acceptable. The larger the T value is, the more significant the path is.

The T values of H1a, H1b, H1c and H1d are all greater than 1.96, and the P values are all less than 0.05. Those result shows that the direct effect of infrastructure support capability, information system support capability, management and operation capability, and economic

foundation promotion capability on global value chain status is significant. T values of H2a, H2b, H2c and H2d are all greater than 1.96, and the P values are all less than 0.05. Those result shows that the direct effect of infrastructure support capability, information system support capability, management and operation capability, and economic foundation promotion capability on regional economy is significant. T value of H3 is greater than 1.96, P value is less than 0.05. This result shows that the direct effect of regional economy on the position of global value chain is significant.

According to the results of mediating effect analysis (Table 5), H4a, H4b, H4c and H4d show that the mediating effect of regional economy in the role of infrastructure support capability, information system support capability, management and operation capability, economic foundation promotion capability on the status of global value chain is tenable through hypothesis test. When the direct effect between independent variables and dependent variables is significant and the indirect effect of mediating variables is significant, that means Partial mediating effect hold. The results show that in the process of the influence of regional logistics capability, on the status of global value chain, regional economy plays a part of intermediary effect, that is, regional logistics capability will positively affect regional economy, thus having an indirect positive impact on the status of global value chain.

**Table 4.** Model hypothesis verification results

Hypothesis	Sample mean (M)	Standard deviation (STDEV)	T value ( O/STDEV )	P value	Test results
H1a	0.145	0.040	3.537	0.000	passed
H1b	0.250	0.043	5.854	0.000	passed
H1c	0.231	0.045	5.140	0.000	passed
H1d	0.200	0.048	4.197	0.000	passed
H2a	0.239	0.042	5.621	0.000	passed
H2b	0.302	0.043	7.057	0.000	passed
H2c	0.183	0.034	5.442	0.000	passed
H2d	0.309	0.035	8.728	0.000	passed
H3	0.179	0.045	4.065	0.000	passed

**Table 5.** Mediating effect analysis results

Hypothesis	Sample mean (M)	Standard deviation (STDEV)	T value ( O/STDEV )	P value	Test results	Mediating effect
H4a	0.043	0.014	3.125	0.002	passed	partial mediating effect
H4b	0.054	0.015	3.610	0.000	passed	partial mediating effect
H4c	0.033	0.010	3.163	0.002	passed	partial mediating effect
H4d	0.055	0.015	3.729	0.000	passed	partial mediating effect

## 2) Model path coefficient and its significance analysis



The model path coefficient and its significance are shown in Figure 2. According to the T statistics between latent variables, the degree of significance can be judged. The T value range of 1.96-2.326 is \*, the T value range of 2.326-3.28 is \*\*, and the T value range of 3.28 and above is \*\*\* [32]. If the T value does not reach 1.96, it means that the hypothetical relationship has not passed the significance test.

By observing the path coefficient of the observed variables of the latent variables, we can get the most influential key indicators in the process of the impact of regional logistics capability on the position of the global value chain. X11 (gross domestic product of transportation, storage and postal industry) has the greatest impact on infrastructure support capability; X23 (number of mobile phones per 10000 people) has the greatest impact on information system support capability; X31 (proportion of employees in logistics industry) has the greatest impact on operation and management capability; X43 (total retail sales of social consumer goods) has the greatest impact on economic infrastructure promotion capability maximum.

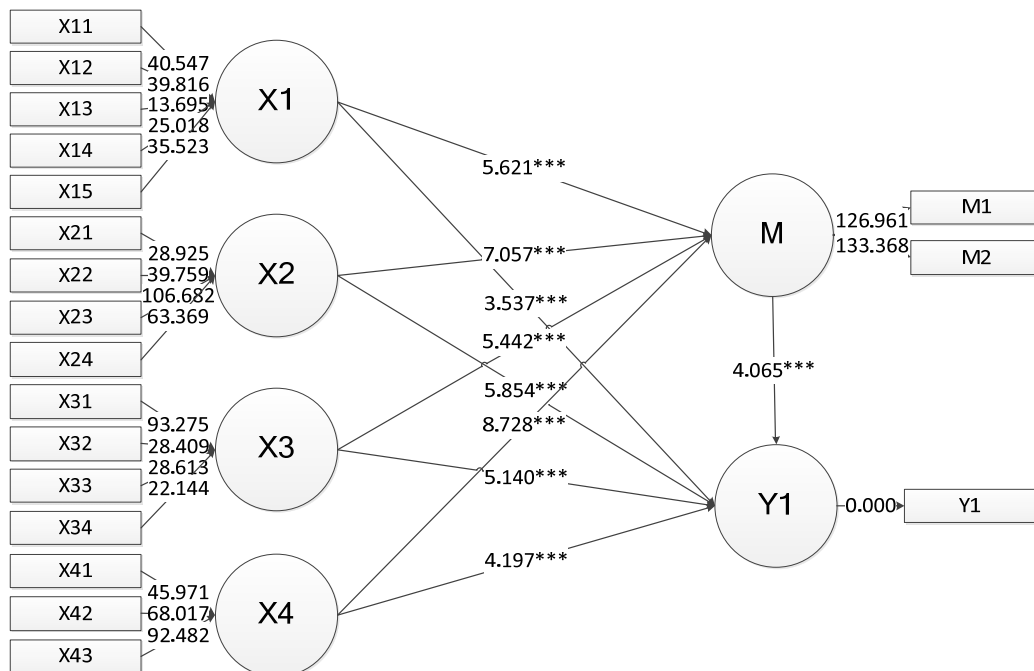


Figure 2. Model path coefficient and its significance

3) Analysis of path effect, explanatory power and predictive power of the model

In this paper, the path effect, explanatory power and predictive power of the model are tested by calculating the effect index  $f^2$ ,  $R^2$  and  $Q^2$ .  $f^2$  is an important index to measure the path effect and influence effect among latent variables in structural equation.  $f^2 > 0.02$  indicates that the path effect is better. The path effect is shown in Table 6, and the results show that the path effect and influence effect of each latent variable in the model maintain a good level.

Table 6. Analysis results of path effect ( $f^2$ )

	Y1	M
X1	0.031	0.101
X2	0.088	0.161
X3	0.093	0.067
X4	0.058	0.171
M	0.031	
Y1		

This paper uses  $R^2$  to evaluate the structural equation model,  $R^2$  must be greater than 0.1, otherwise even if the path coefficient is significant, it can not be accepted. The results are shown in Table 7,  $R^2$  is greater than 0.6, indicating that the model has good explanatory power. In addition, the structure model is tested by the binding function of smartpls. The larger  $Q^2$  is, the stronger the prediction correlation is. The results are shown in Table 7. The results show that the  $Q^2$  values of latent variables are greater than 0, which indicates that the structural model has good predictive power.

**Table 7.** Analysis results of explanatory power ( $R^2$ ) and predictive power ( $Q^2$ )

Latent variables	$R^2$	$Q^2$ (=1-SSE/SSO)
Y1	0.639	0.629
M	0.663	0.561

## 5. SUMMARY AND CONCLUSION

This paper constructs a structural equation model of regional logistics capability and global value chain status with regional economy as intermediary variable, and uses pls and bootstrapping algorithm to verify the impact of regional logistics capability on global value chain status and the intermediary effect of regional economy.

The results show that there is a significant positive impact between regional logistics capability and global value chain status, that is, infrastructure support capability, information system support capability, management and operation capability, and economic foundation promotion capability have a direct positive impact on global value chain status. Among them, (1) infrastructure support capability has the greatest direct impact on the position of global value chain. Infrastructure is an important foundation for value creation and exchange in the global value chain, and it provides a prerequisite for regional logistics activities. Without the infrastructure, no matter the logistics activities within the region (material collection, transportation within the region, production, etc.) or across the region (transportation outside the region, distribution, etc.) can not be carried out, then each region in the global value chain can not form a chain structure, can not complete the global operation process of products or services, and the global value chain will be fundamentally broken. The global value chain will be broken fundamentally; (2) information system support capability also has a direct positive impact on the status of global value chain. With the development of information technology, the cost of global transportation and communication is decreasing. Big data, Internet of things, cloud computing, artificial intelligence and other new generation information technologies are becoming the driving force of global value chain. The information system provides technical and network support for the regional logistics activities, and ensures the smooth flow of business, information and capital. The effective communication of information can ensure the normal operation of regional logistics activities, and the cross regional circulation activities in the global value chain also depend on the transmission of information. Therefore, the direct role of information system support ability in promoting the global value chain can not be ignored; (3) the operation ability of management and economic foundation also have a direct positive impact on the status of the global value chain. Efficient management of logistics activities is one of the important conditions to ensure the smooth progress of logistics activities and complete the operation of global value chain. The number of members in the global value chain is increasing, the scope of demand is expanding, and the process is more complex, which requires more efficient logistics operation management to ensure the operation efficiency of the global value chain. High level and high efficiency operation management is conducive to improve the logistics efficiency and make the region more competitive in the operation of global value chain. The economic foundation provides an important guarantee for the operation of regional

logistics. The regional industrial structure and consumption level will have an impact on the positioning of the region in the global value chain, and then affect the position of the region in the global value chain.

Regional economy has a partial mediating effect in the process of the influence of regional logistics capability on the status of global value chain. This shows that after regional logistics promotes economic development, it will have a secondary impact on the status of global value chain, and form the impact path of "regional logistics capability regional economy global value chain". The improvement of regional logistics capability is conducive to the increase of regional economic benefits. From the government level, the increase of fiscal revenue can better play the leading role of government subsidies in the participation of global value chain, so that the position in the global value chain is rising; from the personal level, consumers are an important part of the global value chain, and the improvement of savings level is conducive to easing the economic crisis Pressure, consumers solve their worries, the level of consumption will continue to improve, which is conducive to promoting the construction of consumer driven global value chain.

In addition, in the global value chain, regional logistics capability has the greatest impact on the four indicators of transportation, storage and postal industry GDP, the number of mobile phones per 10000 people, the proportion of logistics employees, and the total retail sales of social consumer goods, which are the key indicators in the process of impact.

Through this study, we can see that improving regional logistics capability can not only directly promote the status of global value chain, but also promote the development of regional economic benefits, and then promote the status of global value chain. Global value chain links all links through logistics activities, and closely links the production, trade and investment of each region. The logistics activities of each region will not only affect the position of the region itself in the global value chain, but also affect other links and regions in the chain. In the context of the in-depth development of economic globalization, international competition has gradually changed from the first international competition dominated by multinational enterprises to the all-round fierce competition that requires the participation of governments, enterprises and markets. In the process of upgrading the status of global value chain, the government needs to make efforts to improve the logistics capability, promote the development of regional economy, improve the status of global value chain, and constantly move forward to the middle and high end of global value chain, so as to make the region more competitive in the development of economic globalization and integration, and create opportunities for the region to better integrate into the world economy.

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