ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

Measurement of the Chinese Logistics Substitution Elasticity and the Influencing Factors –Base on the VES Model

Duan Jiexin[1,a], Wang Yunxia[2,b]

[1]*Shenzhen Polytechnic School, Shenzhen, China*
[2]*Shenzhen Technology University, Shenzhen, China*
[a] *duanjiexin@szpt.edu.cn*,[b] *wangyunxia@sztu.edu.cn*

Abstract: *Use VES production function to estimate the substitution elasticity of Chinese logistics industry from 1978 to 2017, and the influencing factors were further analyzed. The results show that there are regional differences in the substitution elasticity in the logistics industry, and the substitution elasticity in the more developed eastern regions is higher than in the central and western regions. Through theoretical analysis and empirical test of the affection of logistics substitution elasticity, the conclusion shows that the capital deepening level, the capital return rate, the worker's higher education level, the market opening degree, the government consumption expenditure, the industrial structure factors will affect the factor substitution elasticity of the logistics industry. Therefore, the formulation of regional logistics industry policy should fully consider the influence of various factors, improve the flow efficiency of production factors within the scope of technology accessibility, and promote the coordinated development of regional logistics industry and other industries.*

Keywords: *Substitution Elasticity; VES Production Function; Logistics Industry; Impact Factors*

1. Introduction and Literature Review

With the development of the logistics Industry, it can expand the accessibility of the regional economy, endorse regional economic distribution, and promote the corresponding development of the surrounding areas and associated industries. The globalization of economic activities has endorsed the increase in the occurrence of commercial trades among different countries, and business flow has been leading logistics, which has led to the narrowing of regional economic inequalities, making the distance of the countries, regions, and people closer and closer. Presently, industrial structure is going through adjustment and upgrades, China's economic development has slowed down, and the growth rate of the logistics industry has been declining in recent years. Restricted by the input of production factors, the current logistics industry has problems such as rising labor costs, packed capital investment, and waste of resources. These factors will indisputably lessen the growth quality of the logistics industry. Furthermore, as production material prices continue to rise, to achieve the contribution of factor inputs to industrial growth, an effective way is to achieve the transformation of single factor inputs into rational allocation of factors, and optimize the allocation of factors to achieve industrial standing improvement. Therefore, for the core of the current research on the elasticity of factor substitution in the logistics industry, one important angle is to study the combination of different factors and mutual substitution to improve the cost pressure caused by the increase in factor prices. The second angle is to analyze the factor substitution of the Chinese logistics industry in the context of the coordinated development of regional industries. The flexible development trend and regional differences highlight the importance of the supporting role of logistics in the sustainable development of the regional economy. However, the current research on the substitution elasticity of logistics industry elements has been neglected for a long time.

Mrs. Robinson published "Incomplete Competition Economics" in 1933 and in her book she described the changes in factor income share through two factors which are the change in factor input ratio, and the elasticity of factor substitution. Almost at the same period, Hicks applied factor substitution elasticity to changes in factor income distribution and determined the position of factor substitution elasticity to solve factor allocation problems[1]. For a long time thereafter, the theoretical and applied research on the elasticity of factor substitution is at a stagnation stage, by reason of the problem to set production function model properly and the problem to standardize function

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

standardization. Afterwards, with the proposition of various production functions and their variants in neoclassical economics, Klump and Grandville (2000) argued that the elasticity of substitution needs to be separated by the standardization of production functions. The steps to standardize the production function are outlined [1]. Acemoglu (2002) further disintegrated factor substitution elasticity into factor substitution efficiency and distribution effects, and clarified how factor substitution elasticity affects the bias and path of technological progress [2]. Since then, scholars have adopted standardized CES production functions as the theoretical framework for empirical research, and gradually added modernization factors such as technological improvement factors in the research of economic growth and industrial policy. Industrial development has a certain promoting effect, and the reason why economic growth is greatly affected by industrial development is that changes in factor prices will affect the market size. Numerous scholars have found that neutral technological progress only exists under the scholars' assumptions, and the "real" technological progress must be biased towards a certain factor of production. From the point of view of the factor income distribution theory represented by Carl Marx, the difference in factor inputs will definitely affect the factor income distribution. It can be seen that the focus on the two major economic fields of growth and distribution is still the main theme of the research on the elasticity of factor substitution. Factor substitution elasticity is an important constraint that affects the development of regional industries. The analysis of factor substitution elasticity is a prerequisite foundation for studying issues such as industrial growth, balanced industrial development, and factor income circulation.

From the point of industrial development, due to the scarcity of production materials, the application of factor substitution flexibility in the industrial economy has also attracted the attention of researchers. Affected by the different industrial positions, academic research on the elasticity of factor substitution in the industrial field is limited to industry and agriculture, and academic research on the logistics industry focuses on industrial efficiency, thus the academic researches seldom focus on the aspects of the logistics industry. In the field of research on substitution elasticity and influencing factors. There is heterogeneity in industrial development, and diverse factors of production have sufficient supply or lack of supply within the industry. When production factors are scarce and technological progress is difficult to achieve prodigious progress in the short term, it is particularly important to reflect the combination and substitution of different production factors. In recent years, some scholars have increasingly paid attention to the bias of logistics technology progress. Ouyang Xiaoxun and Huang Fuhua (2014) studied the technological progress index and the bias of technological progress in China's logistics industry, and believed that the regional gap in China's logistics industry's technological progress was narrowing [3]. The trend is that regional logistics technology advancement tends to select the trend of deepening capital. Han Biao et al. (2017) measured that the elasticity of factor substitution in the logistics industry was between 0 and 1 from 1995 to 2014, and verified the view that logistics technology progress is biased towards capital [4]. On this basis, Wang Yunxia and Han Biao (2018) further investigated the growth effect and merging of factor substitution elasticity in China's logistics industry, and their conclusions confirmed the statement that factor substitution elasticity is beneficial to industrial growth [5]. In addition, further research believes that the elasticity of factor substitution not only has a growth effect but also has a certain degree of convergence, which means that the research on the development differences between logistics industries in different regions can be started from the perspective of elasticity of factor substitution and its influencing factors.

Consequently, the research fields related to factor substitution elasticity are mostly hot topics that scholars are paying attention to. Research on factor substitution elasticity will not only help to comprehend the theoretical transmission of its impact on the economy, but also help to formulate economic policies and apply it to related industries. During the research. However, throughout the study of domestic and foreign researchers, researchers pay more attention to the "value" of factor substitution elasticity, and rarely mention the "cause" that affects factor substitution elasticity. Will limit the flexibility of factor substitution and the application value of related research fields. Judging from the current research on the influencing factors of factor substitution elasticity, some researchers believe that there is a certain relationship between factor substitution elasticity and industrial structure. Yuhn (1991) argues that factor prices will affect factor substitution elasticity, and that Korea 's capital-labor substitution elasticity Affected by the price of capital and the relationship between the two is inversely proportional, the Republic of Korea government has adopted a series of price-distorting policies to artificially reduce the price of capital input and promote the substitution of capital for labor[6].Saam (2008) considers that the degree of openness of trade will have an impact on the elasticity of factor substitution. He verified through the H-O model that countries with faster capital accumulation can further increase the elasticity of factor substitution through the level of trade openness[7]. Alvarez-Cuadrado F. et al. (2015) consider that due to differences in productivity growth

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

rates in different sectors, in the case of sectoral differences in substitution elasticity, the flow of production factors is biased towards sectors with relatively high substitution elasticities, which makes the structure of capital and labor Changes are also the main driving factors for industrial structural change.

To sum up, the elasticity of factor substitution is an important factor that affects the development of the logistics industry. The existing research on the factors affecting the elasticity of factor substitution in the logistics industry is scarce, which limits the application value of related research to a certain extent. Therefore, based on the calculation of the substitution elasticity of logistics industry elements, this paper summarizes the important factors that affect the substitution elasticity of logistics industry elements, in order to contribute to the related research of the logistics industry.

2. Estimation and Analysis of Capital-Labor Substitution Elasticity

The analysis of the factors influencing the elasticity of factor substitution in the logistics industry needs to be founded on the measurement of the elasticity of factor substitution. In numerous production functions of measuring the elasticity of substitution of elements, the two production functions CES and VES are generally adopted, because of their advantages of convenient calculation and conformity with social reality. Nevertheless, the substitution elasticity of the elements obtained by the CES production function does not change with different sample points, and has the defect of constant substitution elasticity. The factor substitution elasticity of VES production function changes with the change of factor input ratio and technological progress level, which can make up for this defect. Chen Qingneng (2008) considers that the VES production function has the characteristics of diminishing marginal returns, diminishing marginal technology replacement rate, and the change of the elasticity of substitution with the change of capital per capita. It has respectable statistical characteristics when it is applied to empirical analysis [9].

2.1 Model Construction

From the research objectives of this paper, the choice of production function, considering that the elasticity of factor substitution can reflect the change trend with the scarcity of production factors, this paper calculates the elasticity of factor substitution of logistics industry based on VES production function. In view of this, this paper adopts Zheng Meng's (2017) method for reference. Under the assumption that there are only two factors of production, labor and capital, which are expressed by K and L respectively, the measurement of factor substitution elasticity is based on the following VES production function [10], like formula (1):

$$Y = Af(K,L) = A(E_K K)^{\frac{a}{1+c}}[(E_L L)+(\frac{b}{1+c})(E_K K)]^{\frac{ac}{1+c}} = A[(E_K K)^{\frac{1}{c}}(E_L L)+(\frac{b}{1+c})(E_K K)^{\frac{1+c}{c}}]^{\frac{ac}{1+c}} \quad (1)$$

In formula (1), Y represents output, the variable E_K and E_L represents the efficiency levels of the two production factors K and L respectively. A, a, b and C are indexes of different variables respectively. According to the relevant definitions, it can be inferred that the marginal output of capital and labor is the basis of measuring the elasticity of substitution of elements. The formula (1) can be deduced.

$$\begin{aligned}\frac{\partial Y}{\partial K} &= A\frac{ac}{1+c}E_K[(E_K K)^{\frac{1}{c}}(E_L L)+(\frac{b}{1+c})(E_K K)^{\frac{1+c}{c}}]^{\frac{ac-1-c}{1+c}}[\frac{1}{c}(E_K K)^{\frac{1-c}{c}}(E_L L)+(\frac{b}{c})(E_K K)^{\frac{1}{c}}]\\ \frac{\partial Y}{\partial L} &= A\frac{ac}{1+c}E_L[(E_K K)^{\frac{1}{c}}(E_L L)+(\frac{b}{1+c})(E_K K)^{\frac{1+c}{c}}]^{\frac{ac-1-c}{1+c}}(E_K K)^{\frac{1}{c}}\end{aligned} \quad (2)$$

The marginal technological substitution rate of capital and labor, $MRTS_{KL}$, can be obtained by dividing equation (2)

$$MRTS_{KL} = -\frac{\partial Y}{\partial K}/\frac{\partial Y}{\partial L} = \frac{E_K}{E_L}\frac{(E_K K)^{\frac{1-c}{c}}(E_L L)+b(E_K K)^{\frac{1}{c}}}{c(E_K K)^{\frac{1}{c}}} = -\frac{1}{c}(\frac{L}{K}+b\frac{E_K}{E_L}) \quad (3)$$

Further, according to the definition of element substitution elasticity, the capital labor substitution

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

elasticity is expressed as follows:

$$\sigma_{KL} = d\ln(\frac{L}{K}) / d\ln(MRTS_{KL}) = \frac{K}{L} d(\frac{L}{K}) / \frac{1}{MRTS_{KL}} d(MRTS_{KL}) = 1 + b\frac{E_K}{E_L}\frac{K}{L} \quad (4)$$

Formula (4) shows that the elasticity of factor substitution b is affected by parameter value, per capita capital stock and factor production efficiency ratio. In particular, when b = 0, the elasticity of capital labor substitution will remain unchanged at 1. In addition, when $b\frac{E_K}{E_L}$ >0, the elasticity of capital labor substitution is greater than 1; when $b\frac{E_K}{E_L}$ < 0, the elasticity of capital labor substitution is less than 1.

The "Dallardsville Hypothesis" argues that the elasticity of factor substitution is in direct proportion to economic growth, which has also been verified by many scholars. By taking logarithm from both sides of formula (1), and sorting out, we can get:

$$\begin{aligned} \ln Y &= \ln A + \frac{a}{1+c}\ln(E^K K) + \frac{ac}{1+c}\ln[(E^L L) + \frac{b}{1+c}(E^K K)] \\ &= \ln A + \frac{a}{1+c}\ln(E^K K) + \frac{ac}{1+c}\ln(E^L L) + \frac{ac}{1+c}\ln[1 + (\frac{b}{1+c})(\frac{E^K K}{E^L L})] \end{aligned} \quad (5)$$

From Taylor's expansion, $\ln[1 + (\frac{b}{1+c})(\frac{E^K K}{E^L L})] \approx (\frac{b}{1+c})(\frac{E^K K}{E^L L})$,

Formula (5) can be arranged as follows:

$$\ln Y = \ln A + \frac{a}{1+c}\ln(E^K K) + \frac{ac}{1+c}\ln(E^L L) + \frac{ac}{(1+c)^2}\cdot\frac{bE^K}{E^L}\cdot\frac{K}{L} = \alpha_0 + \alpha_1 \ln K + \alpha_2 \ln L + \alpha_3 k \quad (6)$$

Here, $\alpha_0 = \ln A + \frac{a}{1+c}\ln E^K + \frac{ac}{1+c}\ln E^L$, $\alpha_1 = \frac{a}{1+c}$, $\alpha_2 = \frac{ac}{1+c}$, $\alpha_3 = \frac{ac}{(1+c)^2}\frac{bE^K}{E^L}$

It can be concluded by calculation:

$$\frac{bE^K}{E^L} = \frac{(\alpha_1 + \alpha_2)\ \alpha_3}{\alpha_1 \alpha_2} \quad (7)$$

Take formula (7) into formula (4), and substitute elastic value of element to get:

$$\sigma_{KL} = 1 + \frac{(\alpha_1 + \alpha_2)\ \alpha_3}{\alpha_1 \alpha_2}\frac{K}{L} \quad (8)$$

Based on the derivation of VES production function and the panel data of China's regional logistics industry from 1978 to 2017, this paper estimates the factor substitution elasticity of logistics industry and analyzes the influencing factors through empirical analysis and test.

2.2 Data source and description

Presently, the accounting of the logistics industry in various countries lacks a unified caliber. According to the relevant data statistics of China's Third Industry Statistical Yearbook 1991-2011, the logistics industry is classified and displayed. As shown in Table 1. In table 1, the output value of each logistics subdivision industry accounts for 84% of the output value of the logistics industry, which can approximately reflect the operation status of the logistics industry.

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

Table 1 Proportion of output value of various sub sectors of logistics industry in 1991-2011 Unit(%)

Year	Output value of Transportation	Output value of Storage	Output value of logistics trade	Output value of postal industry	Total
1991	80.9	4.7	13.3	1.1	86.7
1992	79.8	5.3	13.8	1.0	86.1
1993	79.7	5.3	14.1	0.9	85.9
1994	78.1	6.0	15.0	1.0	85.1
1995	77.2	6.5	15.3	0.9	84.6
1996	78.1	5.9	15.0	0.9	84.9
1997	77.9	6.0	15.2	0.9	84.8
1998	78.7	5.7	14.9	0.7	85.1
1999	79.1	5.6	14.7	0.6	85.3
2000	77.5	6.3	15.2	1.0	84.8
2001	77.0	6.6	15.5	0.9	84.5
2002	75.5	7.3	16.4	0.8	83.6
2003	75.5	7.1	16.7	0.7	83.3
2004	76.0	6.8	16.4	0.8	83.6
2005	74.6	7.0	17.6	0.8	82.4
2006	72.0	7.2	18.7	2.2	81.4
2007	74.8	7.0	16.2	2.1	83.9
2008	73.7	7.3	17.0	2.0	83.0
2009	72.8	7.5	17.5	2.2	82.5
2010	72.3	7.6	17.9	2.1	82.0
2011	71.5	7.6	18.7	2.2	81.3
Average	76.3	6.5	16.0	1.2	84.0

Source: Statistical Yearbook of China's tertiary industry 2012

In addition, limited to the limitations of the current statistics on the "logistics industry" and the availability of statistical data, unless otherwise specified, the research data are all from the statistical yearbooks related to 29 provinces and cities (excluding Tibet, and combining Sichuan and Chongqing together). In addition, according to the division method of the East, the West and the East, the elasticity difference of element substitution in different regions is further calculated.

It can be seen from equation (8) that the acquisition of factor substitution elasticity requires three variables of capital stock, labor input and industrial output of logistics industry:

2.2.1 Logistics capital investment

From the perspective of research, many scholars have measured the overall capital stock of our country, but the research on the capital stock of logistics industry is less. This paper adopts the perpetual inventory method proposed by Gordon Smith in 1951, with the formula as $K_{i,t} = K_{i,t-1}(1-\delta) + I_{i,t} / p$. Here, $I_{i,t}$ is the total fixed asset investment and p is the fixed asset investment price index, δ indicates that the depreciation rate is 5.42%, which is the same as the depreciation rate chosen by scholars such as Ma Yueyue when estimating the capital stock of the logistics industry.

(1) Capital stock in the base period. Many scholars will judge and process the acquisition of the capital stock in the base period according to personal experience, but the results are greatly different due to the influence of data, experience and assumptions. Hall and Jone (1999), on the basis of determining the depreciation rate, use the total fixed capital formation to obtain the base period capital stock[13]. The accounting formula $K_{1978} = I_{1978} / (\delta + g_i)$ is used, which g_i represents the geometric average growth rate of investment, δ represents the depreciation rate of the fixed assets of the logistics industry. In addition, Zhang Jun (2004) believes that the calculation of the formula by directly selecting the denominator value of 10% will greatly simplify the calculation difficulty, and this method is used in this paper [11].

(2) Investment amount over the years. For the selection of the investment amount of the year, Zhang Jun (2004) adopted the variable of total fixed capital formation [11], and Li Gucheng et al. (2014) believed that according to China's accounting system, both fixed asset investment and fixed capital

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

formation have the same subject, so they adopted The fixed asset investment amount measures the capital stock of the logistics industry [12]. The data sources are from the "Compilation of Statistics on China's Fixed Assets" and "China Statistical Yearbook on Fixed Assets".

(3) Depreciation rate of fixed assets. The selection of the depreciation rate of fixed assets is based on different research objectives, and the selected depreciation rate is diverse accordingly. Researchers' discussions on the depreciation rate are mostly concentrated in the macroeconomic and industrial fields, and there is no uniform standard for the selection of the depreciation rate of other industries, especially the logistics industry. Hall and Jone (1999) selected a fixed asset depreciation rate of 6%[13], Zhang Jun et al. (2004) believed that the depreciation rate of China 's provincial fixed industry was 9.6%[11], Li Gucheng et al. (2014) chose 5.42% as the depreciation rate of agricultural fixed assets[12] , Ma Yueyue (2015) measured the total factor productivity of the logistics industry under heterogeneous production technology, and selected the depreciation rate of fixed assets in the logistics industry to be 5.42%[14]. Considering the long service life of the fixed assets in the logistics industry, after a trade-off comparison, this paper also selects the depreciation rate of 5.42% to convert the capital stock of the logistics industry.

2.2.2 Labor input data

Measured by the number of employees at the end of the year, and the data sources are from "China Labor and Wage Statistics" and "China Labor Statistics Yearbook".

2.2.3 The output value of the logistics industry

Measured by the added value of the logistics industry, the data are from the "Compilation of Statistical Data of New China for 60 Years" and "Statistical Yearbooks of Provinces", and the data have been processed based on the 1978 data to eliminate the influence of price factors.

2.3 Calculation of the substitution elasticity of China's logistics industry elements

On the basis of obtaining relevant statistical data, use equation (6) to obtain the values of correlation coefficients α_1, α_2 and α_3, and further use equations (7) and (8) to calculate the factor substitution elasticity of the logistics industry in each province. Use the fixed-effect model (FE) and the random-effect model (RE) to test the suitability of the model, and further split the whole country into three regions: east, middle, and west. Compare the elasticity of factors in different regions. Shown in Table 2 in attachment as showed in the end.

Table 2 1978—2017 The suitability test of substitution elasticity in Chines logistics industry

	National		East		Central		West	
Index	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FE	RE	FE	RE	FE	RE	FE	RE
Constant C	-0.568***	0.830***	-0.00888	-0.158	-3.444***	-3.435***	-0.475*	-1.009***
	(0.155)	(0.163)	(0.189)	(0.233)	(0.373)	(0.402)	(0.262)	(0.234)
$\ln K(\alpha_1)$	0.441***	0.447***	0.378***	0.379***	0.574***	0.573***	0.496***	0.508***
	(0.00942)	(0.00940)	(0.0119)	(0.0120)	(0.0206)	(0.0205)	(0.0179)	(0.0178)
$\ln L(\alpha_2)$	0.262***	0.341***	0.233***	0.278***	1.003***	1.000***	0.0169	0.206***
	(0.0461)	(0.0427)	(0.0565)	(0.0549)	(0.0958)	(0.0946)	(0.0902)	(0.0733)
$k(\alpha_3)$	0.0003***	0.0004***	0.0002***	0.0002***	0.0005***	0.0005***	0.0006***	0.0006***
	(1.82e-05)	(1.82e-05)	(1.87e-05)	(1.89e-05)	(4.31e-05)	(4.30e-05)	(4.62e-05)	(4.65e-05)
R^2	0.726		0.782		0.781		0.725	
F	995.4		463.97		414.44		339.69	
σ	0.943		0.999		0.957		0.871	
Obs	1160	1160	400	400	360	360	400	400

Note: in brackets are the estimated t statistic values of variables ****, * *, * indicating that the variables are significant at the levels of 1%, 5% and 10%, respectively

According to the results shown in Table 2, the elasticity of labor output ($\ln L$) in the western region under the fixed effect model fails to pass the significance test, and the values of other parameters are basically significant at the level of 5%. Further, after calculating the values of each region α_1、α_2、α_3,

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

formula (8) shows the element substitution elasticity of each province, city and autonomous region from 1978 to 2017. The average value of element substitution elasticity of each province is listed in details in Table 3 in attachment.

Table 3 1978—2017 Elasticity of substitution of logistics industry elements in all provinces, cities, and autonomous regions

Region	Elasticity of element substitution σ	Region	Elasticity of element substitution σ	Region	Elasticity of element substitution σ
Beijing	1.621	Gansu	0.809	Anhui	0.931
Fujian	0.938	Guangxi	0.962	Hebei	0.976
Guangdong	0.968	Guizhou	0.931	Henan	0.973
Hainan	0.754	Inner Mongolia	0.881	Heilongjiang	0.953
Jiangsu	0.974	Ningxia	0.775	Hubei	0.976
Liaoning	0.991	Qinghai	0.793	Hunan	0.971
Shandong	0.968	Shanxi	0.948	Jilin	0.942
Shanghai	0.940	Sichuan	0.753	Jiangxi	0.931
Tianjin	0.893	Xinjiang	0.929	Shanxi	0.967
Zhejiang	0.950	Yunnan	0.929	Central	0.958
East	1.000	West	0.871	National	0.943

Source: It is based on the calculation of the author.

3. Analysis on the factors affecting the elasticity of substitution of elements in China's logistics industry

The discussion on the elasticity of factor substitution originates from the use of different factors of production in the process of industrial development. From the observation of production function, the substitution between factors not only changes with the change of factor price and factor supply, but also is affected by many external factors.

3.1 Impact of capital deepening level

When the factor price ratio remains unchanged, the substitution elasticity of factors is affected by changes in the supply and demand of factors. From the perspective of factor supply, assuming that some undiscovered resources have been discovered by exploration, or due to the improvement of technical level, some previously unavailable resources can now be used, which will lead to an increase in the supply of production factors. As the supply of this factor of production increases, the price of the factor will be reduced by the increase in the quantity of factor supply. Within the reach of the technological level, producers will increase the use of relatively cheap production factors, while reducing the use of expensive production factors, the elasticity of factor substitution will change accordingly.

3.2 The impact of changes in factor income share

Factor price changes will affect the supply and demand changes of factors. It is assumed that when only two production factors, capital, and labor, will affect market efficiency, the reduction in the proportion of labor factors will increase the wage level in the labor market. Suppose that under the condition that the capital price remains unchanged, the rise in labor price will result in the replacement of part of labor by capital. Zhao Zifang (2006) believes that due to government intervention, China ’s capital factors have excessively subsidized state-owned enterprises, thereby distorting the price of capital factors and their income distribution [15].

3.3 Influenced by education level

From the perspective of factor input in the logistics industry, the urbanization process has an extrusion effect on the rural labor force. From the current labor supply situation, the low-skilled labor force still prefers the productive service industries with lower thresholds such as transportation and warehousing. However, with the continuous deepening of capital, the advancement of logistics

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

technology needs to be matched with high-skilled labor. The current knowledge and skill structure and education level of the logistics industry labor force still need to be improved. This is an important factor restricting the labor productivity of the logistics industry, which in turn affects logistics. The elasticity of factor substitution in industry.

3.4 The impact of market openness

The level of market opening will affect the level of technological progress of the industry to a certain extent. Market opening is usually accompanied by the introduction of technology and capital, which in turn stimulates market vitality. Opening to the outside world and expanding trade are conducive to improving the efficiency of resource allocation, forming economies of scale, and promoting the improvement of technology. Therefore, the elasticity of factor substitution will also be affected by the degree of market opening.

3.5 Government level

All along, China's economic development has been deeply influenced by the government. In addition to being guided by prices, market factor inputs will also be affected by "visible hands." Government intervention in factor inputs has led to factor price distortions. Due to the influence of the fiscal and financial systems, when goods cannot play their role as an exchange medium, inflation will result. High inflation will affect the efficiency of factor allocation and reduce the substitution elasticity of factors. It can be seen that factors such as the government's consumption expenditure level, policies and systems will also affect the flexibility of factor substitution.

3.6 Influence of industrial structure

The combination ratio of production factors is the basic factor that determines the industrial structure, and the comparative advantages of industries with intensive factors are affected by the elasticity of factor substitution [16]. Since different industries have different factor substitution elasticities, within industries with higher factor substitution elasticity, the flexibility of substitutability among elements is higher. Therefore, within the reach of technology, the use of factors tends to be more abundant and low-cost production factors, and the replacement of production factors promotes the continuous upgrading of the industrial structure.

3.7 Other influencing factors

In addition, even in the most efficient market, there are still some factors that can lead to distortions in the factor market, such as underdeveloped factor markets, union forces, and local protectionism. Lack of reasonable factor market architecture. Due to various separation mechanisms, the factors of production cannot flow freely, and thus the effective allocation of factor resources cannot be achieved. In many studies by foreign scholars, trade union power is also an important factor influencing factor substitution. The stronger the trade union power, the higher the bargaining position in the labor market and the less elastic the substitution of capital for labor. In addition, there is often local protectionism in the process of regional competition. The government often intervenes in some elements of the market. When the market price deviates from the market value law, the market price distorts the scarcity of the elements. Based on the above analysis of the factors influencing the elasticity of factor substitution, the following model is established, and the factors affecting the elasticity of factor substitution in the logistics industry are further examined:

$$\sigma_{it} = \alpha_1 + \beta_1 kl_{it} + \beta_2 r_{it} + \beta_3 open_{it} + \beta_4 gov_{it} + \beta_5 edu_{it} + \beta_6 stru_{it} + \varepsilon_{it}$$

The denotations of the explanatory variables in the model are as follows: kl_{it} represents the level of capital deepening, measured by the ratio of the capital stock of the logistics industry to labor input; r_{it} represents the rate of return on capital, and is calculated between the total operating surplus and the capital stock when calculating this data Ratio, the former is composed of both net operating surplus and depreciation of fixed assets; $open_{it}$ represents the degree of regional openness, and calculates this data to select two data of total export trade and gross domestic product; gov_{it} represents the level of government expenditure, the indicator uses government consumption expenditure and GDP ratio;

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

edu_{it} represents the level of higher education, this indicator is expressed as the ratio of the population with higher education to the total population; $stru_{it}$ represents the impact of industrial structure on the elasticity of logistics industry factor substitution, using the ratio of the tertiary industry labor force to the total employment population. In addition, the multi-collinearity that may exist between the variables is eliminated by the stepwise regression method, and the regression results are listed in Table 4 gradually. In this process, the sign of the same explanatory variable maintains strong stability, and the model is relatively robust.

Table 4 Regression analysis of factors affecting the elasticity of substitution of elements in China's logistics industry

Variable description	(1)	(2)	(3)	(4)
Capital deepening(kl)	0.143***	0.133***	0.124***	0.0899***
	(6.60)	(6.17)	(5.64)	(3.19)
Return on capital(r)	-1.036***	-0.631*	-0.680*	-0.59
	(3.14)	(1.84)	(1.90)	(1.63)
Higher education level(edu)	-2.284***	-2.290***	-2.393***	-2.416***
	(26.40)	(26.63)	(27.80)	(27.83)
Market openness($open$)		0.409***	0.423***	0.380***
		(3.91)	(4.04)	(3.55)
Government consumption expenditure(gov)			1.702***	1.557***
			(3.69)	(3.33)
industrial structure($stru$)				0.771*
				(1.93)
Constant c	4.488***	4.417***	4.432***	4.421***
	(30.85)	(30.30)	(28.66)	(28.58)
Observed value	1160	1160	1091	1090
$R-squared$	0.419	0.426	0.461	0.463

Note: the parameter values in brackets of equation (1) to (6) are t values; ***, **, * represent the significance levels of 1%, 5% and 10%, respectively.

From the significance of the explanatory variables in equation (1) - (4) in Table 4, except that the capital return rate in equation (4) has no significant effect on the elasticity of capital labor substitution, all the other explanatory variables have passed the significance level of 10%. In equation (1) - (4), the impact of capital deepening level on the level of capital labor substitution is positive, and both are significant at the level of 1%, which shows that the higher the level of capital deepening in logistics industry, the greater the elasticity of capital labor substitution. From the existing research, the current technological progress of logistics industry is capital biased technological progress.The expansion speed of capital investment is higher than that of labor investment. The growth of China's logistics industry is based on capital expansion. This means that with the increase of labor cost, the progress of logistics technology tends to capital, and the trend of capital deepening appears. When the level of capital deepening is high, it indicates that the production process needs professional production equipment, and the mode of production division depends on equipment at a high level. Capital deepening is accompanied by the extrusion of capital to labor force, and the substitution of capital to labor force is high.

In equation (1) - (4), the effect of capital return on the elasticity of capital labor substitution is negative, which shows that the elasticity of capital labor substitution increases with the decrease of capital return. Factor price is reflected by the level of factor income. When the level of capital factor income is reduced, that is, the price of capital is reduced, under the condition that the existing technology level is unchanged, the producer will increase the input of capital factor and reduce the input of labor factor, which will lead to the increase of capital labor substitution elasticity.

In equation (1) - (4), the effect of higher education level on the elasticity of capital labor substitution is negative, and the significant level of 1% is passed. When the education level of workers is improved, the elasticity of capital to labor force becomes smaller, which shows that with the improvement of logistics technology, the existing logistics industry service capacity is not enough to meet the needs of higher economic development. In this case, more high-quality labor is needed to meet the upgrading needs of the logistics industry, so improving the education level of employees can

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

enhance the industrial innovation ability, improve production efficiency and further promote industrial development. The improvement of production efficiency is realized by adopting the production mode of large-scale and mass production. This production mode will lead to some links in the production process that must be intervened by "people", and at the same time, there will be some links where capital plays an independent role, in which capital cannot replace the role of labor force.

In equation (3) - (5), the effect of market openness on the elasticity of capital labor substitution is positive, which shows that higher openness can more efficiently introduce foreign advanced technology and production technology, and learn and transform them into their own use, leading to technological innovation. When a certain factor of production is relatively lacking, the bias of technological progress will reduce the use of the factor of production. Assuming that the price of the factor remains unchanged, technological innovation can obtain the same output when reducing the use of a certain factor of production. It can be seen that the investment proportion of production factors is optimized by technological innovation. The more open the market is, the higher the elasticity of capital labor substitution is.

In equation (4) - (5), the impact of government consumption expenditure on the elasticity of capital labor substitution is positive. From the perspective of the structural proportion of government consumption expenditure, education expenditure and cultural expenditure cost are important components of government consumption expenditure. The improvement of the education level of labor force or the technical proficiency of employees can be achieved by increasing education expenditure, thus improving labor productivity. Within the range of technology, the higher the labor productivity, the lower the labor input.

In equation (5), the influence of industrial structure on the elasticity of capital labor substitution is positive, and the increase of the proportion of labor force in the tertiary industry will contribute to the improvement of the elasticity of substitution of factors in the logistics industry. The industrial structure of an industry is affected by many factors, and one of the most important basic factors is the combination ratio of production factors. At present, China's industrial structure is undergoing an important period of change, and the proportion of service industry has exceeded that of manufacturing industry and further improved. As a productive service industry, the task of logistics industry is to improve the efficiency by reducing the time of commodity circulation and reduce the cost of production and operation on the basis of ensuring the supply quality of manufacturing industry. From the perspective of industrial structure, the technology diffusion of producer services is the source of transformation and upgrading of manufacturing industry. The capital of producer services mainly depends on the accumulation of manufacturing industry. The promotion of manufacturing industry in the global value chain will enhance the collaborative development ability of logistics industry and manufacturing industry. With the continuous optimization of industrial structure, the efficiency level and technological innovation level of logistics industry will also be improved, and the substitutability of production factors will be improved.

4. Conclusion

Based on the VES production function, in this paper we estimate the factor substitution elasticity of China's logistics industry from 1978 to 2017, and conduct theoretical analysis and empirical research on the factors that affect the factor substitution elasticity of the logistics industry. The empirical results show that factors such as the deepening level of capital, the rate of return on capital, the level of higher education, the degree of market opening, government consumer spending, and changes in industrial structure will all affect the factor substitution flexibility of the logistics industry to varying degrees. In recent years, related research on the logistics industry, such as the continuous improvement of the level of logistics technology, the choice of logistics technology, the elasticity of factor substitution in the logistics industry and industrial growth, the total factor productivity and factor endowment of the logistics industry, the factor income distribution and industrial structure Etc., all need to be based on the research of the factor substitution elasticity. Besides, from the current literature review on the substitution elasticity of logistics industry factors, research on the influencing factors of logistics industry factor substitution elasticity has not been carried out in depth. Based on this, this paper conducts in-depth analysis of this issue, and discusses the mechanism by which various factors affect the elasticity of factor substitution. The conclusions form our research indicate the following inspirations:

The factor substitution elasticity is an important parameter to measure the degree of flexibility in

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

economic development. The factor substitution elasticity of the logistics industry in different regions is different. The factor substitution elasticity of China's logistics industry presents a pattern of high in the east and low in the west. To a certain extent, the logistics industry capital and labor in the eastern region have a higher degree of substitutability. When a certain factor of production is affected by external factors and the price rises, the producer can easily use another factor of production. Replacement, thereby reducing the impact of changes in the external environment on the industry, is also the reason why the flow of logistics industry elements in the eastern region is more flexible than the central and western regions.

Further,The level of capital deepening is proportional to the changing trend of the capital-labor substitution elasticity in the logistics industry. From the supply of existing factors of production, we can see that the supply of labor is limited, and the level of capital deepening continues to intensify. While capital deepening will increase the productivity of the logistics industry, it will also affect the distribution of production factors. At present, all industries are facing the problem of a reduction in the proportion of labor income due to the deepening of capital deepening.

The rate of return on capital is opposite to the direction in which the elasticity of capital-labor substitution in the logistics industry changes. The rate of return reflects the price of factors. The decrease in the rate of return of capital means that the price of factor of capital is reduced. When the cost of input to capital is reduced, producers increase their investment in capital and reduce the input of labor. Capital-labor Replacement flexibility is improved. However, from the perspective of the current factor income distribution pattern, affected by capital-biased technological progress and capital intensity, the labor income share shows a downward trend, while the capital return rate shows an upward trend. From the perspective of the impact of both the rate of return on capital and the elasticity of factor substitution, under the current situation where the share of power income is decreasing, the issue of improving the distribution of factor income by analyzing the distribution effect of elasticity of factor substitution is worthy of further study.

The improvement of laborers' higher education level reduces the flexibility of capital-labor substitution in the logistics industry. With the continuous deepening of capital and the continuous improvement of the level of technological progress in the logistics industry, the demand for highly skilled labor will further increase. On the one hand, the increase in the education level of workers will increase production efficiency. In some production links, it will be difficult for capital to replace high-skilled labor; on the other hand, the increase in worker efficiency directly affects the income level of workers and shrinks. One of the effective ways of factor income gap is to improve the education level of workers. Therefore, in the current urbanization process in China, the government should increase the investment in continuing education for migrant workers and urban unemployed people, and improve the performance of educated people in the labor market through high-level education.

The degree of market opening is directly proportional to the direction of changes in the substitution elasticity of the logistics industry. By expanding the opening level of the logistics industry and introducing technology, the logistics industry's division of labor will be promoted in the direction of refinement. The increase in the level of openness to the outside world, while making up for the lack of capital investment, improves the technical level of the logistics industry through the technology spillover effect of FDI, thereby improving the investment efficiency of the industry. But it is worth noting that the degree of openness to the outside world should match the development level of the regional logistics industry. In theory, when the gap between the development level of the regional logistics industry, labor skills, and imported capital is large, the technology spillover effect of capital investment will not be effective Exertion will even squeeze out capital investment and reduce the investment efficiency of the logistics industry. Therefore, the market opening degree of the logistics industry should fully consider the suitability and matching degree.

Finally, government consumption expenditure and industrial structure help to improve the flexibility of factor substitution in the logistics industry. Government consumption expenditure is to provide public products and services for the whole society, which reflects the level and ability of government governance to a certain extent. With the continuous improvement of the current scientific and technological level, the public has put forward higher requirements on the level of government governance. The government should adapt to the refined needs of the government governance model and maximize the effectiveness of government consumption expenditure. In addition, the industrial structure expressed as the proportion of the labor force in the tertiary industry has improved the elasticity of factor substitution in the logistics industry. However, as the proportion of the tertiary industry structure continues to deepen, the logistics industry as a producer service industry, the improvement of production factor circulation efficiency helps to reduce the consumption of circulation

ISSN 2616-5902 Vol. 3, Issue 8: 92-103, DOI: 10.25236/AJBM.2021.030816

links, thereby promoting the coordinated development of regional logistics industry and other industries.

For further research, with the recent trend of the technology advance in FinTech area, the logistics industry shows a new trend adopting FinTech innovations such as the usage of big data, blockchain, artificial intelligence, cloud computing and others. This will provide the new opportunity to develop logistics industry and especially the logistics finance to achieve the coordinated development of logistics and capital flow, which will furthermore promote the improvement of technological and financial aspects in the logistics industry, thus provide new impact on factor substitution elasticity in the logistics industry. Therefore, it will be preferable to investigate in the future research how the innovation of logistics technology will affect logistics finance and the factor substitution elasticity, and how they will furthermore advance the logistics industry.

References

[1] Klump,R., De La Grandville . Economic Growth and the Elasticity of Substitution-Two Theorems and Some Suggestions [J]. The American Economic Review, 2000: 90(1):282-291.
[2] Acemoglu D.Direct Technical Change[J].Review of Economic Studies,2002,69:781-810.
[3] Ouyang Xiaoxun, Huang Fuhua. Technological Progress and Technological Preference of China's Logistics Industry [J]. Finance and Trade Research, 2014 (03): 66-74.
[4] Han Biao, Wang Yunxia, et al. China's Logistics Industry Factor Substitution and Technological Progress Preference [J]. Soft Science, 2017 (10): 23-26 .
[5] Wang Yunxia, Han Biao. Technological progress bias, factor endowment and green total factor productivity of logistics industry [J]. Journal of Beijing University of technology and Technology (SOCIAL SCIENCE EDITION), 2018 (2): 51-61
[6] Yuhn K H. Economic Growth, Technical Change Biases, and the Elasticity of Substitution: A Test of the De La Grandville Hypothesis[J]. Review of Economics & Statistics, 1991, 73(2):340-346.
[7] Saam M. Openness to Trade as a Determinant of the Macroeconomic Elasticity of Substitution [J]. Journal of Macroeconomics, 2008, 30(2):691-702.
[8] Alvarez-Cuadrado,F.etal(2017),"Capital labor substitution, structural change and growth", Theoretical Economics12: 1229-1266.
[9] Chen qingneng. Main properties and mathematical proof of VES production function [J]. Journal of Zhejiang University of science and technology, 2008, 20 (2): 81-86.
[10] Zheng Meng, Yang Xianming. Research on income distribution effect under factor substitution growth mode -- Empirical Analysis Based on China's inter provincial panel data [J]. Nankai economic research, 2017 (2): 55-75.
[11] Zhang Jun, Wu Guiying, Zhang Jipeng. Estimation of China's inter provincial physical capital stock: 1952-2000 [J]. Economic research, 2004 (10): 35-44.
[12] Li Gucheng, fan Lixia, Feng Zhongchao. Capital accumulation, institutional change and agricultural growth -- an empirical estimation of China's agricultural growth and capital stock from 1978 to 2011 [J]. Management world, 2014 (5): 67-79.
[13] Hall Robert, Jones Charles. Why do some countries produce so much more output per worker than others?[J].The Quarterly Journal of Economics,1999,1(114) :83-115.
[14] Ma Yueyue, Wang Weiguo. Total factor productivity of China's regional logistics industry under heterogeneous production technology [J]. Systems engineering, 2015 (10): 63-72.
[15] Zhao Zifang, Shi Jinchuan. Industrial efficiency loss caused by distorted factor market in China -- An Empirical Analysis Based on DEA method [J]. China industrial economy, 2006 (10): 40-48.
[16] Li Yaoxin, Wu Jiapei. Allocation principle of production factors in industrial structure adjustment [J]. Economist, 1994 (5): 61-74.