Original Research Article

Impact of Standard Differences on Position in Agricultural Global Value Chains

Abstract: The development of agricultural global value chains (AGVCs) has led to the rapid development of intermediate goods trade, agricultural products need to cross between several countries, so that more different technical standards such as SPS (Agreement on the Application of Sanitary and Phytosanitary Measures) /TBT (Technical Barriers to Trade)between countries have been imposed by countries around the world with regard to the quality and safety of agricultural products, which lead the burden of trade costs increase prominent.This paper examines whether the extent to which SPS/TBT measures differ between countries in the agricultural sector affects their position in global value chains, based on the bilateral trade value added data in the OECDinter-country input-output database, combing the social network analysis and UNCTAD database from 2010 to 2018,measure the positions of countries in the agricultural global value chains and the standard differences of SPS/TBT among countries. We use the gravity model to empirically inspect the impact of the SPS/TBT standards heterogeneity between countries (regions) on the AGVCs position. We find: (1) structural differences in SPS/TBT standards among countries negatively affect the centrality of GVCs; (2) the negative impact of standards difference on the total and forward centrality is more serious than backward centrality; (3) The negative impact of the SPS/TBT difference is more pronounced in developing countries.

Keywords:SPS/TBT; standard differences; global value chain position; agriculture

1. Introduction

Global trade in agricultural products has changed dramatically since the beginning of the 21st century.According to FAO(Food and Agriculture Organizationof the United Nations), The State of Agricultural Commodity Markets 2020,Since 1995, the volume of international trade in agricultural products has more than doubled, from $680 billion in 1995 to $1.5 trillion in 2020.[1]

[1] https://www.fao.org/family-farming/detail/en/c/1310953/

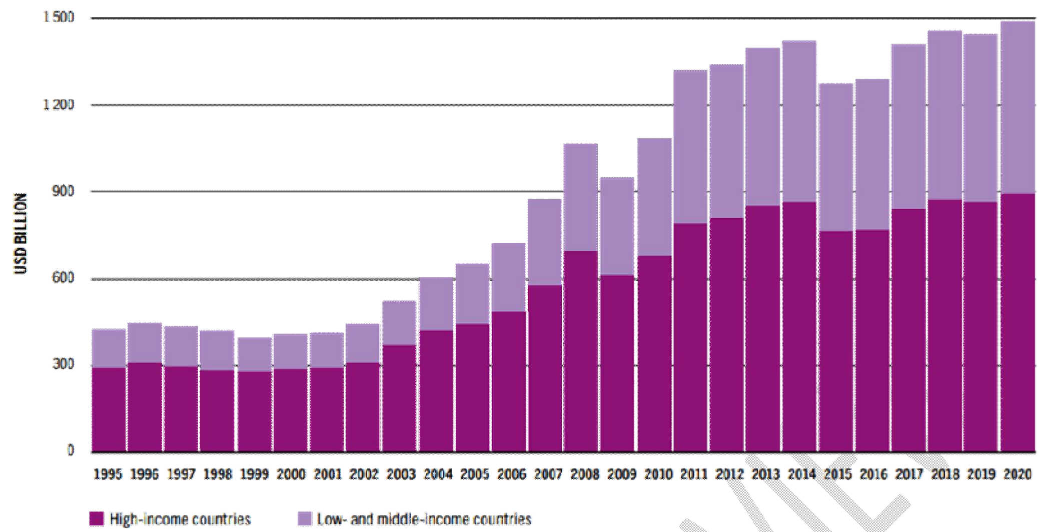

Fig. 1.1 The Evolution of Global Food and Agricultural Trade, 1995–2020

The production model of global value chains (GVCs) implies that the production of a product needs to cross national borders several times and completes different stages of production and value-added phases in different countries. The higher GVCs position, the stronger the country's international competitiveness and profitability in GVCs. In the formed AGVCs system, developed countries often occupy the core and leading position in the value chain by virtue of advanced technology and sufficient market information; as for developing countries, they are mainly engaged in the supply of raw materials, primary processing and other links, the profit and control ability are restricted, faced with the dilemma of "low-end locking".

Economic globalization has put forward higher requirements for trade freedom, and world tariffs have shown a trend of gradual decline, with countries turning to more covert non-tariff measures (NTMs) to impose trade restrictions on other countries.

The planting process of crops requires the application of chemical fertilizers and pesticides, compared with the manufacturing and service industries, agriculture is more vulnerable to the constraints of specific restrictive standards and testing requirements for harmful substances such as pesticides and additives that affect the natural environment and human health and safety, and is more affected by non-tariff measures.

Due to the gap in the level of development and technology among countries, there are also significant differences in the type, quantity and severity of standards applied in agricultural products, which can be mainly divided into depth heterogeneity, breadth heterogeneity and structural heterogeneity.

In AGVCs, every production link must meet the corresponding standards, so the compliance cost burden caused by the inconsistency of standards between countries will be amplified by this production mode, become an important obstacle for countries to participate in the production of global value chains. So, it is evident that standards differences related to technical standards, regulations, etc. have become a major obstacle to world agricultural products trade. The question concerned in this paper is: how does standards difference affect a country's position in AGVCs, and what is the magnitude of its impact?

For the importance of this paper, the research perspective of this paper is innovative and expands the research on the influencing factors of global value chain position. At present, a large number of existing studies focus on quantifying the traditional factors that affect trade, such as human capital and technical level, and testing the degree and mechanism of their influence on trade flow and trade margin through empirical models, and mostly from the perspective of importing countries unilaterally imposing SPS/TBT measures on exporting countries, which cannot reflect the impact of standard differences between countries on the position of global value chain. In view of this, this paper calculates the structural differences of SPS/TBT measures from the perspective of the differences between countries, and explores the impact of the differences between a country's technical standards and its trading partners on the position of global value chains.

2.Literature review

The first literature closely related to this paper is the measurement of the position in global value chains and related research on influencing factors. The measurement of the position is mainly divided into the following three methods. First, accounting based on value added trade. Hummel et al. (2001) propose the vertical specialization (VS) indicator (HIY); Koopman et al. (2014) integrate the above indicators in a unified framework (KPWW). Second, calculation of the number of production stages. Fally (2012) further propose the use of production segmentation length to measure the production length of global value chains; Wang et al. (2017) construct a production decomposition model (WWYZ). Third, the method of social network analysis. Social network consists of nodes and links between nodes, nodes represent individuals in the social network, and links represent substantial connections between individuals (Scott, 1991). Network centrality is a measure of the centrality of nodes in social networks and their ability to acquire and control resources. Specifically in the global value chain, high centrality represents that a country or region is in the core position of the global value chain and has comparative advantages. Empirical studies have shown that network centrality can significantly improve the division of labor of a country's agricultural sector in the global value chain (Ma ,2016). On the other hand, the influencing factors about the industry's position in the global value chains are mainly resource endowment, technology level, human resources and policies, which can be divided into internal factors formed due to the country's own characteristics, and external factors formed by external policy support and supporting facilities (Li, 2022).

The second strand of literature relevant to this paper is on the measurement of standard differences and trade effect related studies. There are three main measurement methods. First, frequency ratios and import coverage. These two indicators are mainly used for overall comparison and analysis between countries, but do not take into account the issue of heterogeneity and endogeneity of specific provisions of SPS/TBT measures on the product level (Penello, 2014). Second, the trade protection index. Otsuki et al. (2001) use maximum residue limit levels (MRLs) to reflect the level of trade protection of SPS/TBT measures for different products. Third, ad valorem equivalents (AVEs). The basic idea of the AVEs is to convert the trade effect generated by trade measures into the tariff value of the same effect for comparison, which realizes the measurement and comparison between different kinds measures and different products, with a wide range of application

On the study of the trade effect of non-tariff measures, scholars reached different conclusions. Fernandes et al. (2019) find that when the importing country has a stricter level of MRLs than the exporting country, it will reduce the trade possibility. Fiankor et al. (2021) conclude that higher standards for agricultural products reduce trade volume between countries. Cheng Hong et al. (2017) believe that while actively responding to the differences and high standards of other countries, enterprises will improve their ability to comply with more stringent standards, which will create new competitive advantages for enterprises, and the resulting positive effect will offset the compliance costs incurred by enterprises to meet the standards.

To summarize,the measurement and analysis of GVCs are mostly focused on the manufacturing and service industries, and there are few articles focusing on AGVCs. Previous studies on factors affecting AGVCs were mostly conducted from the perspective of traditional comparative advantages such as labor force, education level, technology level, scientific research and FDI. As an important factor affecting agricultural trade, scholars mostly studied the promoting or inhibiting effects of SPS/TBT measures on countries' participation in global trade. Few studies from the perspective of standard heterogeneity to study the impact of differences in technical regulations and standards among countries on the division of labor of countries in AGVCs In view of this, due to the formation and development of trade networks between countries, countries participating in the global value chain are interconnected, so it is reasonable to shift the research perspective of agricultural product standards from importing country standards to bilateral standard differences and coordination, and further expand the bilateral standard differences from deep coordination to structural heterogeneity.

3.Data and methodology

3.1Standard Differences

Different from the methods mentioned above that measure standard differences based on unilateral country, the method used in this paper is based on bilateral countries. For example,Assume that both countries X and Y impose A21 (SPS maximum residue limit requirement) and A84 (SPS Sanitary and Phytosanitary inspection) on a product (other bone-in beef, fresh or chilled) code HS020120 as compliance assessment procedures for this product, so the SPS/TBT structural difference between countries X and Y is 0 for the first two measures; However, Country Y also imposed A83 (SPS Sanitary and Phytosanitary certification) on HS020120 products, increasing the difference in the structure of the SPS/TBT measures between the two countries. Country Z imposes only one non-tariff measure A14 (SPS Special Permit) requirement for HS020120, so the structural differences between Country Z and Country X and Y are greater than between countries X and Y. To extend this calculation method to the country-sector level and calculate the structural heterogeneity of SPS/TBT standards in agricultural sectors between countries is the standard difference index needed in this paper.

For two countries*i* and countries*j* in year *t*, the structural heterogeneity of the SPS/TBT standard is as follows:

$$RD_{ijt} = \frac{1}{k}\sum_{k}\left|NTM_{ikt} - NTM_{jkt}\right| \tag{2-2}$$

where k indicates a particular product-regulation combination. NTM_{ikt} is a dichotomous variable equal to one when country i implements a particular type of regulation on a particular product at time t and zero otherwise.

Next, calculating the differences in standards at the country-sector level. The structural heterogeneity of SPS/TBT standards in the agricultural sector h of countries i and j in year t is as follows:

$$RD_{ijt}^{h} = \frac{1}{k^{h}}\sum_{k \in I^{h}}\left|NTM_{ikt} - NTM_{jkt}\right| \tag{2-3}$$

Where I^h denotes a set of potential product-regulation combinations within sector $\hbar$, k^h denotes the total number of product-regulation combinations observed worldwide (of our sample countries) within sector $\hbar$.

Finally, since the country position in agricultural GVCs is a relative relationship between a country's agricultural sector and all sample countries, the country-sector standardized structural heterogeneity needs to be further processed to obtain the standard differences between the agricultural sector of country i and all other sample countries in year t. Refer to Inui et al. (2021), compute the overall regulatory distance of country i's sector h in year t from the global norm by taking an average of bilateral regulatory distances of country i across its trading partner country j's for sector $\hbar$ using the sectoral value-added as weights. The specific calculation formula is as follows:

$$Weighted\ RD_{it}^{h} = \sum_{j \neq 1} S_{jt}^{h} RD_{ijt}^{h} \tag{2-4}$$

Where S_{jt}^{h} is the share of the trading partner country j in the world total value-added of sector h in year t.

3.2 Position in AGVCs

Drawing on Criscuolo and Timmis (2018), we calculate the Bonacich-Katz eigenvector centrality indicator for the position of a country's agricultural sector in the global agricultural trade network. For node i, the eigenvector centrality index is in fixed proportion to the indices of all the nodes connected to it, so the eigenvector centrality of country i is as follows:

$$c_i = \frac{1}{\lambda}\sum_{j \in M(i)} c_j = \frac{1}{\lambda}\sum_{j=1} A_{ij} c_j \tag{2-5}$$

Where A_{ij} denotes the adjacency matrix. When node j is the neighbor of i, A_{ij} = 1, otherwise, A_{ij} = 0. As the matrix A of each item can represent a real number of connection strengths, connection strengths in trade networks refer to the trade volume. $M(i)$ is the set of all connection node i in the network, and N is the total number of nodes, λ is a constant. Sum up the number of associations a node has with other nodes is found and weighted by the centrality of all nodes,the measurement model of network power index (Centrality Index) is as follows:

$$c_i = \sum_j w_{ij}\left(\alpha + \beta c_j\right) \tag{2-6}$$

Where w_{ij} is the value assigned to the strength of the connection between the nodei and j; c_j is the node j's centrality, therefore, i's centrality is equal to the sum of the number of relationships it has with other points, and is weighted by the centrality of all other points. α,β are correction parameters, α is a normalized constant, which does not affect the relative centrality; the value of β reflects how much the power of a node depends on the power of other nodes. Applying the trade in value-added data to Eq. (2-6), obtain the eigenvector centrality of GVC features at the country or country-sector level and further differentiate the total centrality into forward centrality $c_i^{Forward,h}$ and backward centrality $c_i^{Backward,h}$ at the country-sector level

$$c_i^{Forward,h} = \alpha + \beta \sum_j W_{ij}^{D,h}\, c_j^{Forward,h} \tag{2-7}$$

$$c_i^{Backword,h} = \alpha + \beta \sum_j W_{ij}^{U,h}\, c_j^{Backword,h} \tag{2-8}$$

Where $W_{ij}^{U,h}$ and $W_{ij}^{D,h}$ are upstream and downstream input linkages between country i and country j within sector h, respectively. Let Z_{ij}^{h} denote input flows from country i to country j within sector h; upstream and downstream input linkages are defined as $W_{ij}^{U,h} = \frac{Z_{ij}^{h}}{\sum_i Z_{ij}^{h}}$ and $W_{ij}^{D,h} = \frac{Z_{ij}^{h}}{\sum_j Z_{ij}^{h}}$, respectively. The parameter α is a scaling factor; thus, it is less crucial to determine centrality in relative terms. The parameter β is the key parameter to determining the importance of higher-order linkages. β is usually considered to be less than the reciprocal of the largest eigenvalue of the input linkage matrix, $W_{ij}^{U,h}$ and $W_{ij}^{D,h}$. Therefore, we set both α and β to be equal to 0.5. Equations (2-7) and (2-8) can be further expressed in the following matrix form:

$$c^{Forward,h} = \alpha 1 + \boldsymbol{\beta} W^{D,h} c^{Forward,h} \tag{2-9}$$

$$c^{Backward,h} = \alpha 1 + \beta W^{U,h} c^{Backward,h} \tag{2-10}$$

where $c_i^{Forward,h}$ and $c_i^{Backward,h}$ indicate the n × 1 vector of backward and forward centralities of each of the n country-sectors, respectively. $W_{ij}^{U,h}$ and $W_{ij}^{U,h}$ are n × n matrices that denote upstream and downstream input linkages between country i and j within sector h. Finally, taking the inverse matrix of Eq. (2-9) and (2-10), the backward and forward centralities can be derived as follows:

$$c^{Backward,h} = \alpha\left(I - \beta W^{U,h}\right)^{-1} 1 \tag{2-11}$$

$$c^{Forward,h} = \alpha\left(I - \lambda W^{D,h}\right)^{-1} 1 \tag{2-12}$$

The total centrality is the average of the backward and forward centrality as follows:

$$c^{Total,h}=\frac{1}{2}\left(c^{Forward,h}+c^{Backward,h}\right) \quad (2\text{-}13)$$

3.3Data and Descriptive Statistics

The measurement of agricultural GVC feature vector centrality indicators in the paper uses the University of International Business and Economics' GVC Index database (UIBE GVC Index), whichare calculated according to the 2021 version of the according to the OECD countries' intersectoral input-output table.The 2021 version of the OECD countries' intersectoral input-output data contains a total of 1995 -2018 data for 45 sectors for 66 countries. Therefore, this paper calculates centrality indicators and standard difference indicators in 66 countries and regions from 1995 to 2018.The indicators of forward linkage and backward linkage among countries and the data of trade added value are from UIBE GVC Index database. SPS/TBT measures from UNCTAD TRAINS database; The data on MFN tariffs comes from the WITS database, created by the World Bank in collaboration with UNCTAD. Descriptive statistics are shown in Table 1.

Table 1. Descriptive statistics of the variables

Variable	Description	2010				2018			
		Mean	Std.dev.	Min.	Max.	Mean	Std.Dev.	Min.	Max.
c_{it}^{Total}	Totalcentrality	0.627	0.16	0.366	2.555	0.653	0.287	0.403	3.185
$c_{it}^{Forward}$	Forward centrality	0.723	0.152	0.384	3.264	0.594	0.321	0.345	3.524
$c_{it}^{Backward}$	Backward centrality	0.532	0.168	0.349	1.846	0.712	0.254	0.462	2.846
$Weighted\ RD_{it}^{h}$	Standard Difference	0.652	0.108	0.354	2.723	0.116	0.176	0.008	0.426
$Tariff_{it}^{h}$	tariff restrictions	2756	1548	5.813	5246	6563	3285	8.462	7348
$Size_{it}^{h}$	Market size	0.532	0.125	0.163	0.864	0.113	0.084	0.121	0.968

Note: Calculate by author.

3.4Estimating equation

The purpose of this study is to examine the impact of standard differences on the position in AGVCs, The specific model is as follows:

$$ln\left(Centrality_{it}^{h}+1\right)=\beta_0+\beta_1 Weighted\ RD_{it}^{h}+\beta_2 lnTariff_{it}^{h}+\beta_3 lnSize_{it}^{h}+\delta_i+\delta^h+\varepsilon_{it}^{h} \quad (2\text{-}1)$$

where $Centrality_{it}^{h}$ denotes the centrality of the agricultural sector h of country i in year t; $Weighted\ RD_{it}^{h}$ denotes the weighting standard difference of the agricultural sector h of country i in year t, to measure the degree of variation in SPS/TBT measure standards; $Tariff_{it}^{h}$, which represents the tariff imposed on the agricultural sector h of country i in year t; $Size_{it}^{h}$, which represents the market size of the agricultural sector *h* of country i in year t; δ_i and δ^h are two sets of fixed effects; ε_{it}^h is the error term.

4. Estimation results

Table 2 gives the results of a benchmark regression on the impact of standardized differences in SPS/TBT measures between a country and other countries on the country's position in AGVCs. Column (1) is total centrality, and columns (2) and (3) estimate the effect on forward and backward centrality, respectively. Columns (1) and (2) indicate that Weighted *RD* has a significant negative effect on total and forward centrality of AGVCs, significant at the 5% level. Controlling for other variables, from the perspective of economic significance, for every 1% increase in the standard difference between a country and other countries, the country's position in AGVCs decreases by about 0.13%. Column (3) shows that the effect of standard differences on backward centrality, although less significant than on aggregate and forward centrality, also produces a significant negative effect at the 10% level. Therefore, it can be concluded that standard differences have a hindering effect on the position in AGVCs. Standard differences weaken the centrality of Agricultural sector in both upstream and downstream. Therefore, the regression results show that the difference of standards has a restraining effect on the centrality of AGVCs.

The sign of the coefficient on market size is the same as expected, and the effects on total, forward and backward centrality are all significant at the 5% level, indicating that agricultural market size positively contributes to the country's position in the AGVCs, and has a greater effect on forward centrality than backward centrality. The possible reason may be due to the fact that upstream of AGVCs are mainly the supply chain of agricultural means of production, such as seeds, fertilizers and pesticides, which are mainly influenced by scarce natural resources and the R&D intensity of the industry, market concentration is high, and thus the impact effect from market size is greater.

The coefficients on the impact of tariffs on the centrality of agricultural GVCs are all positive, which do not match expectations, but none of them are significant. For the reason, under the WTO framework and free trade agreement, the tariff level of agricultural products has declined steadily, restrictive effect of traditional tariff barriers on agricultural products trade is on the whole decreasing trend. Compared with non-tariff barriers, the impact of tariff on trade is small, so it is not significant in the empirical results.

Table 2. The effect on GVC centrality using centred variables.

	(1)	（2）	（3）
	Total centrality	Forward centrality	Backward centrality
Sample	Full	Full	Full
Weighted RD	-0.1346** (0.0284)	-0.2462** (0.0312)	-0.0842* (0.0638)

Size	0.224** (0.0126)	0.228** (0.0246)	0.0184** (0.00564)
Tariff	0.0364 (0.0538)	0.0227 (0.0543)	0.0546 (0.0763)
Year FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
R-squared	0.648	0.573	0.846

Note: Value in parentheses is robust standard error in Country-sector level; ***, ** and * indicates passing the significance test at the 1 %, 5 %, and 10 % level, respectively.

5. Heterogeneity Analysis

In order to test the existence of heterogeneity impact of SPS/TBT measures on the centrality of global value chains in developed and developing countries, and the inhibition effect on developing countries is more obvious, we selectASEAN countries as typical representative of emerging economies, and conducts regression on the ASEAN+10 sub-samples after the regression of the full sample, and compares and analyzes the regression results.

Table 3 presents the regression results of the heterogeneity test for the impact of SPS/TBT measures on countries at different levels of development. In particular, columns (1) (3) and (5) show the standard differences effects on the centrality indicators when we limit the sample to the overall sample, columns (2) (4) and (6) show the standard differences effects on the centrality indicators when we limit the sample to the ASEAN+6 countries.

The results show that the impact of standard differences on the AGVCs total, forward and backward centrality is still significant, and the impact on the sub-sample of ASEAN countries is larger than that of the whole sample. This result indicates that standard differences restrict free trade, brings additional cost burden to exporting countries, and exert more significant negative effect on developing countries. And the total, forward and backward centrality of AGVCs in developing countries has been further reduced.

Table 3. Country heterogeneity regression results

	(1)	(2)	(3)	(4)	(5)	(6)
	Totalrelative centrality		Forwardrelativecentrality		Backwardrelativecentrality	
Sample	Full	ASEAN	Full	ASEAN	Full	ASEAN
Weighted RD	-0.1346** (0.0284)	-0.2642** (0.168)	-0.2462** (0.0312)	-0.3841** (0.2612)	-0.0842* (0.0638)	-0.164** (0.158)

Relative Size	0.224**	0.342***	0.228**	0.168**	0.0184**	0.0842**
	(0.0126)	(0.00487)	(0.0246)	(0.0842)	(0.00564)	(0.0062)
Tariff	0.0364	-0.126**	0.0227	-0.342*	0.0546	-0.261**
	(0.0538)	(0.364)	(0.0543)	(0.265)	(0.0763)	(0.132)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.648	0.884	0.573	0.672	0.846	0.842

Note: Value in parentheses is robust standard error in Country-sector level; ***, ** and * indicates passing the significance test at the 1 %, 5 %, and 10 % level, respectively.

Since producers in developed countries have higher technical levels and rich resources to adjust product production to meet the standards of importing countries, while exporters in developing countries have lower technical levels and longer production cycles of agricultural products, and a series of improvement measures taken by the exporting country such as the purchase of new equipment, training of production and testing personnel, and improvement of existing production processes require a long process, so it is impossible to use lower cost losses in a short time to meet the standard requirements of the importing country's products. So standard differences between countries have a significant inhibiting effect on developing countries. But it may also means that promoting a high level of harmonization of technical standards among countries and narrowing the differences in standards among countries will be more beneficial to emerging economies and developing countries.

From the regression results of other variables, compared with the overall sample regression, the impact of tariffs on the sub-samples is significantly negative, indicating that the impact of tariffs on agricultural products of different economies is heterogeneous, and there is a significant negative effect on emerging economies. The possible reason is that in the process of tariff cuts, low-income and middle-income countries also experience lower tariff cuts than high-income economies.

According to the statistics in the UNCTAD database, in 2018, the average tariff level of agricultural products in high-income countries was about 6%, and the import tariff level of food and agricultural products in low - and middle-income countries was about 10%, 4% higher than the tariff level of high-income countries, so tariffs have a more obvious negative effect on the agricultural sector in developing countries. It has hindered the further integration of the agricultural sector in developing countries into the AGVCs and improved the international competitiveness.

6.Conclusions and Implications

In this study, we use the University of International Business and Economics GVC Index database (UIBE GVC Index)and social network analysis to measure the eigenvector centrality of the agricultural global value chain in 39 countries (regions) from 1995 to 2018, and measures the positions of countries in the agricultural global value chains. Combining the SPS/TBT measures in the UNCTAD NTMs Database, then we get the standard differences of SPS/TBT among countries. Finally, we usethe gravity model to empirically study the impact of regulatory structure differences of non-tariff measures on a country's (region's) global value chain position.

The main conclusions are as follows:(1) structural differences in SPS/TBT standards among countries negatively affect the centrality of GVCs; (2) the negative impact of standards difference on the total and forward centrality is more serious than backward centrality; (3) The negative impact of the SPS/TBT difference is more pronounced in developing countries

International standards are an important part of international trade rules, and standard coordination and integration have become an inevitable requirement for countries to carry out in-depth trade cooperation. Therefore, combining the research conclusions and the actual situation,for OECD countries who want to move their position in AGVCs, this paper puts forward the following policy recommendations:

(1) To learn the advanced standards of developed countries, we should face up to the product standards in trade, strive to improve our own scientific and technological level, and actively respond to the impact of foreign standard barriers.

(2) To actively carry out bilateral and intra-regional free trade agreement negotiations, while absorbing and adopting the agricultural standards of other countries, enhance the structural similarity with the agricultural standards of other countries, reduce the cost of agricultural export trade, and enhance the international competitiveness and influence of the country.

(3)To optimize the trade layout of agricultural products, implement the strategy of diversification of foreign trade of agricultural products, and promote the coordination of agricultural standards with trading partners, so as to enhance the stability and sustainability of agricultural export trade.

(4) Tounswervingly transform the mode of agricultural development, deepen the opening up of agricultural products to the outside world, improve agricultural production standards, actively harmonize with other national standards, comprehensively enhance the competitiveness and standardization level of agricultural trade, so as to consolidate the foundation of stable development of agriculture, and make agriculture truly respond to various risks and challenges.

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