The Impact of the Processing and Foreign Trade of Agricultural Products on Agricultural Modernization: An Empirical Analysis Based on Cointegration and VEC Model

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Abstract Based on the data related to the Chinese and world agricultural production and trade from 1986 to 2011, this paper uses the principal component analysis, cointegration and vector error correction model to perform the empirical analysis of the impact of processing, import and export of agricultural products on the agricultural modernization in China. The results show that the processing and export of agricultural products play a role in promoting the agricultural modernization in China, while the import of agricultural products has some negative effects on the agricultural modernization in China. The negative effects of the import of agricultural products are from the limitations of farmers' small-scale operation and foreign trading partners' protectionism. China should further develop the processing industry of agricultural products, and strengthen the role of downstream industries in promoting the agricultural modernization; improve the level of large-scale and intensive operation, and make good use of WTO rules, in order to provide the necessary market conditions for the agricultural modernization.

Key words Agricultural modernization, Processing of agricultural products, Import and export of agricultural products, VEC model

1 Introduction

Proposal of the Chinese Communist Party Central Committee on Formulating the Twelfth Five-Year Plan for National Economic and Social Development clearly states that we will promote agricultural modernization while developing industrialization and urbanization. The 18th National Congress of Communist Party of China points out that we will stick to the road of new industrialization, informatization, urbanization and agricultural modernization with the Chinese characteristics. Agricultural modernization is an important goal of the current economic and social development in China. Promoting the agricultural modernization is an important way to improve China's comprehensive agricultural production capacity, ensure the effective supply of agricultural products, increase farmers' income, narrow the gap between urban and rural areas, the gap between industry and agriculture and regional disparities, build a comprehensive well-off society, and enhance the comprehensive and coordinated economic and social development.

The processing industry of agricultural products is not just the extension and continuation of agriculture. It plays an irreplaceable role in stimulating agricultural development, improving the level of agricultural industrialization, and promoting the agricultural modernization building. Meanwhile, with the deepening of opening up, the external dependence degree of China's agriculture has been significantly improved. Therefore, it is necessary to perform an empirical study of inherent relationship of processing of agricultural products, foreign trade and agricultural modernization, and explore the degree of impact of processing of agricultural products and foreign trade on the agricultural modernization. It is of important practical significance to designing the blueprint for China's agricultural modernization building.

For the influencing factors of agricultural modernization, degree of impact and path, there have been many studies for useful discussion. Xia Chunping (2010) considers that industrialization and urbanization have promoted the development of agricultural modernization. Chen Zhifeng *et al.* (2012) believe that accelerating the process of industrialization is bound to promote agricultural modernization. Liu Yu (2007) maintains that the dislocation between rural economy and urban economy, between agriculture and non-agricultural sectors, between farmers and urban citizens, is an important factor restricting the coordinated development of agricultural modernization and urbanization in China. The empirical studies of Wang Bei (2011) show that industrialization and urbanization do not Granger cause agricultural modernization. The studies of Jiang Huiming and Wang Zhenhua (2012) on Jilin Province show that the three are not synchronized, and the progress of industrialization will enhance the level of urbanization and agricultural modernization in lag phase 1. Xie Jie (2012) examines the threshold effect of China's industrialization and urbanization in the agricultural modernization process, indicating that only after exceeding a certain threshold can the development of agricultural modernization be promoted. Yin Chengjie (2011) believes that the industrialization and urbanization in some areas fiercely compete for money, manpower and the interests with agricultural modernization, hampering the lasting development of agriculture.

Based on the existing studies, it can be found that the focus of research of scholars is put on the analysis of association and simultaneous development of industrialization, urbanization and

Received: April 25, 2014 Accepted: June 29, 2014

Supported by Business Management Discipline Cultivation Project of Rongchang Campus of Southwest University (RCQG207001).

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agricultural modernization. So far, we have not yet witnessed the literature on the study of agricultural modernization building from the perspective of processing of agricultural products and foreign trade. In view of this, the paper uses cointegration analysis and vector error correction model, to perform an empirical analysis of the impact of processing of agricultural products and foreign trade on the agricultural modernization, in order to provide a new reference for the building of agricultural modernization in China.

2 Research methods and data description

2.1 Variable building

2.1.1 The processing of agricultural products. The processing industry of agricultural products is the industrial production activity with the farming, forestry, animal husbandry and fishery products and their processed products as raw materials, including agro – food processing industry, food industry, beverage industry, tobacco product industry, textile industry, apparel, shoes and hat manufacturing, leather, fur and feather manufacturing, wood processing, wood, bamboo, rattan and grass manufacturing, furniture manufacturing, paper making industry, printing industry and rubber manufacturing.

This paper uses the ratio of output value of processing industry of agricultural products to total output value of agriculture, to describe the degree of processing of agricultural products (hereinafter abbreviated as "*DOP*"). The calculation formula is shown in formula (1):

$$DOP = \frac{\text{Output value of processing industry of agricultural products}}{\text{Output value of the primary industry}}$$

2.1.2 Foreign trade. The foreign trade of agricultural products includes import and export of agricultural products. This paper uses the import of agricultural products (hereinafter abbreviated as "*MOA*") and the export of agricultural products (hereinafter abbreviated as "*XOA*") to describe the basic situation of foreign trade of agricultural products in China.

2.1.3 Agricultural modernization. Different scholars use different measurement methods for the degree of agricultural modernization. Xia Chunping *et al*. (2010) use the level of agricultural mechanization to measure the level of agricultural modernization in a country or region. Wang Bei (2012) uses the labor productivity of the agricultural sector to measure the level of agricultural modernization in China. Wang Xuezhen *et al*. (2005) consider that the indicators that reflect the level of agricultural modernization include food production per unit area of arable land, application rate of fertilizer per unit area of arable land, per capita GNP, urbanization rate, and total agricultural machinery power per unit area of arable land. Wu Xuxiao (2012) believes that the indicators that reflect the level of agricultural modernization include agricultural land productivity, per capita disposable income of farmers, agricultural labor productivity, and the total agricultural machinery power.

Although the above measurement methods make sense to some extent, there are diverse factors influencing the agricultural production, and using the single indicator to measure will inevitably be biased. It is necessary to use multiple indicators to measure the agricultural modernization from different perspectives, but there is a causal relationship between input indicators and output indicators. More importantly, the above method ignores the impact of agricultural labor force's scientific and cultural quality on the agricultural modernization. In fact, there will be no real agricultural modernization if without the modernization of farmers. This paper is to study the effects of processing of agricultural products and trade on the agricultural production capacity.

In view of this, taking into account the availability of data, this paper measures the level of agricultural modernization in one country from the mechanization of agricultural production, infrastructure building, modern agricultural science and technology, environment optimization and practitioners' knowledge (related indicators as described in Table 1). And it uses the principal component analysis to integrate these indicators into one comprehensive evaluation indicator for agricultural modernization (Modernization, hereinafter abbreviated as "*M*"), and its calculation steps are summarized as follows:

(i) Calculate the sample correlation matrix R after pretreatment;

(ii) Calculate the eigenvalues and variance contribution rate of matrix R and rank them in descending order.

(iii) Calculate eigenvector α that eigenvalue corresponds to;

(iv) Calculate the square root of eigenvalues and the product of square root of eigenvalues and the corresponding eigenvectors, namely the factor load.

(v) Calculate the product of the original indicator matrix X and principal component eigenvector α (the derived column vector is the comprehensive indicator of agricultural modernization).

Table 1 The agricultural modernization and its indicators

First-level indicators	Descriptive indicators
Mechanization of agricultural production	Total agricultural machinery power per unit area of arable land(M_1)
Infrastructure building	Effective farmland irrigation rate (M_2)
	Farmland embankment protection rate(M_3)
Modern agricultural science and technology	application rate of fertilizer per unit area of arable land(M_4)
	Mulching proportion of arable land(M_5)
Ecological optimization	The proportion of soil erosion control area to total area of arable land(M_6)
Knowledgeable employees	Rural labor force's educational attainment(M_7)

2.2 Cointegration and VEC model During the regression analysis for revealing the causal relationship, the single - equation OLS method has been widely used, but a basic assumption of OLS method is stable economic variables. However, in the empirical studies, most macroeconomic variables are non-stationary, with a time trend, and using the OLS method for non-stationary economic variables may produce "spurious regression". The cointegration method and error correction model (ECM) were developed by Engle *et al*. (1987), through the use of Wald statistics to test the significance of related variable coefficients in ECM and judge the short-term and long-term causal relationship between the variables, which provided a new way of thinking to solve the "spurious regression" of model.

Although the two series are non-stationary, their linear combination is stationary, indicating that there is a long-run equilibrium relationship between them. Therefore, this paper takes cointegration and error correction model as the basic analysis tool.

Usually there are two methods for the cointegration test of time series data: EG two-step method and Johansen cointegration test. The former is mainly used for testing the cointegration relationship between two variables, while the latter is mainly used for testing the cointegration relationship among multiple variables. Therefore, this article will use Johansen cointegration test method to test whether is cointegration relationships between variables, and establish vector error correction model (VCE model) on this basis to test the ability of long-term equilibrium relationship to adjust short-term fluctuations.

2.3 Model selection Engle and Granger combine cointegration and error correction model to establish the vector error correction model. VEC model is the VAR model containing cointegration constraints, and it is often used for the modeling of non-stationary time series of cointegration relations.

VEC model established in this article is as follows:

$$\Delta y_t = \alpha ECMM_{t-1} + \sum_{i=1}^{p-1}\beta_i \Delta y_{t-i} + \sum_{i=1}^{p-1}\gamma_i \Delta x_{t-i} + \varepsilon_t \qquad (2)$$

where y is the endogenous dependent variable (agricultural modernization M); ECM is the error correction term; p is the lag of VAR model, and since the first-order differential form is used in VEC model, the lag is $p-1$; x is the exogenous variable (degree of processing of agricultural products DOP, export of agricultural products XOA, import of agricultural products, MOA); ε is the innovation term.

2.4 Sample data selection, data sources and data processing

2.4.1 Sample data selection and data sources. Limited by the availability of data, this article selects the data related to China's agricultural production and trade in the period 1986 - 2011 as the basic data for research. China's agricultural production data are from *China Rural Statistical Yearbook* and *China Statistical Yearbook* in the period 1987 - 2012, and the data related to the import and export of agricultural products in China are from WTO database (http://stat.wto.org/Statistical Program).

2.4.2 Data processing. The data on rural labor force's educational attainment is measured based on the years of education. Traditional calculation formula is as follows:

$$M_{it} = \sum_{i=1}^{n} L_{it} h_i \qquad (3)$$

where M_{it} is the aggregate of t years of education; L_{it} is the number of employees with t years of education at level i; h is the years of education at level i.

To avoid simple homogeneous summation of years of education, the current relatively reasonable solution is to use Schulz's measurement way for the years of education, totalling the original years of education through the use of impact of different education levels on labor productivity as the weight.

The formula is as follows: $M_{it} = \sum_{i=1}^{n} L_{it} h_i S_i$ (4)

where S_i is the contribution rate of various levels of education.

For the division of years of education based on education level standards, this article learns from and moderately transforms the approach of Song Yingjie (2010): 1 year of education is for the illiterate and semi-literate are 1; 7 years of education are for the primary school; 10 years of education are for the junior high school; 13 years of education are for the senior high school (including technical secondary school and vocational school); 18 years of education are for the junior college and higher education (including undergraduate, master and PhD), corresponding to $h_1 - h_5$.

For the contribution rate (S_i) of different levels of education, there are great differences in the estimation results at different stages of economic development in different countries. Based on the actual situation of China's rural development and phase characteristics of the data, this article uses the measurement data of Zhou Xiao *et al*. (2003).

Assuming that the contribution rate of the illiterate and semi - illiterate is 1, then the contribution rate of the primary school is 1.070, the contribution rate of the junior high school is 1.254, the contribution rate of the senior high school is 1.308, the contribution rate of the junior college and higher education is 1.634, corresponding to $S_1 - S_5$, respectively.

3 Empirical results and analysis

3.1 Calculation of the related index

3.1.1 Calculation of the level of agricultural modernization Using the EVIEWS 6.0 software, we perform the principal component analysis of $M_1 - M_7$, and the results are shown in Table 2.

Table 2 Principal component analysis results of M_1 - M_7

	The first principal component	The second principal component	The third principal component
Eigenvalues	5.050	1.532	0.352
Contribution rate//%	72.142	21.891	5.025
Cumulative contribution rate//%	72.142	94.034	99.059

From Table 2, it can be found that the eigenvalue of the first and second principal components is 5.050 and 1.532, respectively; the cumulative contribution rate of the first and second principal components reaches 94.034%, indicating that the first and second principal components contains 94.034% of the information of the original 7 indicators.

According to the extraction principle of factor with eigenvalue of greater than 1, the first and second principal components extracted can replace the original 7 indicators. The eigenvector of the first and second principal components is shown in Table 3.

Table 3 The eigenvector of the first and second principal components

		The first principal component	The second principal component
Eigenvector	Total agricultural machinery power per unit area of arable land(M_1)	0.195	-0.016
	Effective farmland irrigation rate (M_2)	0.046	0.599
	Farmland embankment protection rate(M_3)	0.192	-0.044
	application rate of fertilizer per unit area of arable land(M_4)	0.125	0.418
	Mulching proportion of arable land(M_5)	0.196	0.076
	The proportion of soil erosion control area to total area of arable land(M_6)	0.190	-0.168
	Rural labor force's educational attainment(M_7)	0.176	-0.289

Thus, we get the following principal component evaluation model:

$$F_1 = 0.195M_1 + 0.046M_2 + 0.192M_3 + 0.125M_4 + 0.196M_5 + 0.190M_6 + 0.176M_7 \quad (5)$$

$$F_2 = -0.016M_1 + 0.599M_2 - 0.044M_3 + 0.418M_4 + 0.076M_5 - 0.168M_6 - 0.289M_7 \quad (6)$$

The proportion of eigenvalue of each principal component to total eigenvalues of the extracted principal component is regarded as the weight to calculate the principal component integrated model:

$$F = \frac{\lambda F_1 + \lambda_2 F_2}{\lambda_1 + \lambda_2}(\lambda_1 = 5.050,\ \lambda_2 = 1.532) \quad (7)$$

where F is the agricultural modernization level index M.

3.1.2 The calculation of the degree of processing of agricultural products. According to equation (1), the relevant data about China's agricultural production and processing are used to calculate the degree of processing of agricultural products (*DOP*). As space is limited, the calculation results are omitted.

3.2 Unit root test Using the cointegration theory, there is a need to first empirically test whether the variables have the same order of a single whole. In this paper, we use the currently widely used ADF unit root test method to carry out the unit root test of time series *DOP*, *XOA*, *MOA* and *M*. The results are shown in Table 4.

Table 4 Unit root test results of time series *DOP*, *XOA*, *MOA* and M

Variable	Testing variables	Testing forms(c,t,k)	ADF statistic	Critical value 1%	Critical value 5%	Order of single whole
DOP	Original value	($c,t,0$)	-0.691 382	-4.374 307	-3.603 202	I(1)
	First-order difference	($c,0,0$)	-4.767 503	-4.394 309	-3.612 199	
MOA	Original value	($c,t,0$)	-1.608 826	-4.374 307	-3.603 202	I(1)
	First-order difference	($c,0,1$)	-4.736 343	-3.752 946	-2.998 064	
XOA	Original value	($c,t,0$)	-0.378 101	-4.374 307	-3.603 202	I(1)
	First-order difference	($c,0,0$)	-3.945 394	-3.73 7853	-2.991 878	
M	Original value	(c,t,0)	-1.286 519	-4.374 307	-3.603 202	I(1)
	First-order difference	(c,0,0)	-4.734 132	-3.73 7853	-2.991 878	

Note: c and t in the testing forms represent the constant term and trend term; k represents the lag; ADF test critical value is from the software Eviews 6.0; the lag k is automatically selected by the software according to the SC information criterion.

Conspicuously, at the 5% significance level, the time series *MOA*, *DOP*, *XOA* and *M* are of the same order of single whole, satisfying prerequisites for the cointegration analysis.

3.3 Johansen cointegration test Prior to the use of VAR model for analysis, there is a need to test whether there is a cointegration relationship between the related variables. In this paper, we carry out the Johansen cointegration test of the time series *MOA*, *DOP*, *XOA* and *M*. The results are shown in Table 5, and Table 6.

Table 5 Johansen test results of variables

Null hypothesis: The number of cointegration vectors	Characteristic root	Maximum eigenvalue statistic	0.05% critical value	P value
None*	0.648 228	61.374 26	54.079 04	0.009 7
At most 1*	0.517 892	37.344 48	35.192 75	0.028 9
At most 2*	0.410 038	20.563 98	20.261 84	0.045 5
At most 3	0.306 767	8.426 937	9.164 546	0.068 9

Note: * indicates that the null hypothesis is rejected at the 5% level.

Conspicuously, the eigenvalue statistics reject the null hypothesis of zero cointegration vector at the 5% significance level, indicating that within the sample interval, there is a cointegration relationship among the time series of *DOP*, *XOA*, *MOA* and M.

According to the test results, it can be found that the cointegration equation of impact of degree of processing of agricultural products (DOP), export of agricultural products (XOA) and import of agricultural products (MOA) on agricultural modernization (M) is shown in formula (8) below:

$$M = 0.786DOP + 1.842XOA - 0.988MOA - 6.136 \quad (8)$$

Table 6 The normalized cointegration vectors

M	DOP	XOA	MOA	C
1.000000	−0.786 039	−1.842 194	0.988 11	6.135 827
	(−0.145 65)	(−0.524 70)	(−0.289 70)	(−1.257 51)
	[5.396 766]	[3.510 947]	[−3.410 804]	[−4.879 346]

Note: The data in the parentheses are the standard error, and the data in brackets are t statistic.

3.4 Granger causality test Cointegration test only shows the presence of long-term stable equilibrium relationship between variables, but it can not determine whether this relationship is a causal relationship (Toda *et al.*, 1995).

Therefore, we use Granger causality test under non-stationary sequence to test whether the degree of processing of agricultural products (DOP), export of agricultural products (XOA) and import of agricultural products are the reason for changes in agricultural modernization (M). The Granger causality test results of M and DOP, XOA and MOA are shown in Table 7.

Obviously, at the 10% significance level, the degree of processing of agricultural products (DOP), export of agricultural products (XOA) and import of agricultural products (MOA) are the causes of agricultural modernization (M) changes.

3.5 VEC model In order to test the ability of long-term equilibrium relationship between the degree of processing of agricultural products (DOP), export of agricultural products (XOA) and import of agricultural products (MOA), and agricultural modernization (M), to adjust short-term fluctuations, this paper establishes the VEC model of agricultural modernization (M) to the degree of processing of agricultural products (DOP), export of agricultural products (XOA) and import of agricultural products (MOA).

First, the lag of VAR model constituted by the variables to be tested is determined. VAR model lag should select the p values simultaneously and mostly recognized by the amount of information of LR, FPE, AIC, SC and HQ. The results are shown in Table 8.

Table 7 The Granger causality test results of *M* and *DOP*, *XOA* and *MOA*

The null hypothesis	Lag	Obs	F value	P value
DOP does not Granger cause M	3	23	6.143 32	0.005 6***
M does not Granger cause DOP	3	23	0.062 34	0.978 9
XOA does not Granger cause M	3	23	2.688 53	0.081 3*
M does not Granger cause XOA	3	23	1.998 11	0.154 9
MOA does not Granger cause M	3	23	3.971 26	0.027 2**
M does not Granger cause MOA	3	23	0.977 28	0.428 0

Note: * indicates that the null hypothesis is rejected at the 10% significance level; ** indicates that the null hypothesis is rejected at the 5% significance level; *** indicates that the null hypothesis is rejected at the 1% significance level.

Table 8 Lag selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−3.760 976	NA	2.46e−05	0.739 141	0.938 097	0.782 319
1	54.228 16	88.364 40*	4.68e−07	−3.259 825	−2.265 041	−3.043 931
2	71.063 35	19.240 22	5.28e−07	−3.339 367	−1.548 757	−2.950 758
3	94.286 52	17.693 84	4.83e−07	−4.027 287	−1.440 851	−3.465 965
4	134.720 6	15.403 46	2.56e−07 *	−6.354 344	−2.972 081	−5.620 306
5	2 169.609	0.000 000	NA	−198.629 4*	−194.451 3*	−197.722 7*

As can be seen from the table, when the lag is 5, it is recognized by three of five information quantities at the same time (*), and there is a need to build the VAR model with lag of 5, so this paper builds the VEC model with lag of 4 (excluding items not significant). The results are shown in formula (9) below:

$$\begin{aligned}\Delta M_t = &-1.342ECM_{t-1} + 0.773\Delta M_{t-1} + 0.562\Delta M_{t-2} + \\ &(-5.710) \quad (4.066) \quad (3.339) \\ &0.356\Delta M_{t-3} + 0.296\Delta M_{t-4} + 1.868\Delta XOA_{t-3} - \\ &(2.184) \quad (2.545) \quad (2.916) \\ &0.528\Delta DOP_{t-1} + 0.357\Delta MOA_{t-1} - 0.729\Delta MOA_{t-2} - \\ &(-3.672) \quad (3.125) \quad (-2.303) \\ &0.464\Delta MOA_{t-4} - 0.580 \\ &(-1.788) \end{aligned} \quad (9)$$

Figures in parentheses are t statistics; ΔMOA term is significant at the 10% level.

3.6 The results and explanations In terms of the cointegration equation and vector error correction model, the processing of agricultural products and the export of agricultural products, have a long-term positive impact on China's agricultural modernization; the import of agricultural products has a long-term negative impact on China's agricultural modernization.

The coefficient size of error correction term reflects the adjustment of deviation from the long-term trends. When some factors cause the international competitiveness of agricultural products in China to deviate from the long-term trends and generate short-term fluctuations, the adjustment (−1.342) will put the non-equilibrium state back to equilibrium.

There are several possible explanations as follows:

(i) The processing of agricultural products and the export of agricultural products provide a broad market for the sale of agricultural products (Chen Xiwen, 2000; Michio W *et al.*, 2009), to solve the "difficulty in selling" of agricultural products, and stimulate the development of agriculture.

(ii) The development of processing industry of agricultural products can extend the agricultural industry chain to make agriculture get rid of the status of merely providing raw materials and primary processed products, and effectively improve the overall efficiency of agriculture (Du Ying, 2000), thus increasing the income of farmers and enhancing the enthusiasm of farmers for agricultural production.

(iii) China's agriculture has long implemented the small-scale decentralized family management, lacking the ability to absorb modern production factors and mode of operation (He Xiurong, 2009), so it is difficult to cope with fierce competition from foreign modern agriculture, and adjust the agricultural structure. In addition to rampant trade protectionism, China and the major agricultural trading partners open the market unequally, exacerbating the "difficulty in selling" of the domestic agricultural products, reducing the efficiency of agriculture, and hindering the development of agriculture.

4 Conclusions and policy recommendations

4.1 Conclusions According to the empirical findings, it is found that the processing of agricultural products and the export of agricultural products, have a long-term positive impact on China's agricultural modernization. China's small-scale decentralized family agricultural management lacks the ability to absorb modern production factors and mode of operation, so it is difficult to cope with fierce competition from foreign modern agriculture. In addition to rampant trade protectionism, China and the major agricultural trading partners open the market unequally, exacerbating the "difficulty in selling" of the domestic agricultural products and making the domestic high-end agricultural market occupied by the foreign agricultural products, thereby having significant negative effects on China's agricultural modernization.

4.2 Policy recommendations Based on the above conclusions, we put forth the following policy recommendations.

4.2.1 Further developing the processing industry of agricultural products, and strengthening the role of downstream industries in stimulating agricultural modernization. It is necessary to list the processing industry of agricultural products as the important target of new industrialization, and increase efforts to support leading enterprises; innovate upon the system of agricultural operation, and strengthen the vertical collaboration between downstream industries and agriculture; actively provide the necessary modern factors of production for agriculture, improve the level of agricultural industrialization, and promote the Chinese agriculture to transform from traditional agriculture to modern agriculture.

4.2.2 Improving the large-scale and intensive agricultural operation. Under the premise of adhering to the principles of abiding by laws, voluntariness and compensation, it is necessary to encourage and support the professional able farmers, family farms and farmers' cooperatives to contract land; encourage and guide the city industrial and commercial capital to develop the planting and breeding industry suitable for enterprise management in rural areas; strongly support the farmers' cooperatives, joint household business, professional farmers and family farms, and guide them to adopt the advanced technology and modern production factors and transform the mode of agricultural operation according to the requirements of specialization and standardization.

4.2.3 Flexibly using the WTO rules to provide the necessary market conditions for China's agricultural modernization. It is necessary to oppose the trade protectionism and resist all kinds of trade barriers, so as to promote the equal open market between the trade barriers, and create good market access conditions for the export of agricultural products in China. At the same time, it is necessary to make full use of the legitimate rights and interests stipulated by the WTO rules for China, and moderately protect the domestic agricultural production.

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