Asian Agricultural Research 2015, 7(3): 18 –24

# Impact of Agricultural Modernization, Economic Growth and Industrialization on the International Competitiveness of Agricultural Products: Based on the Empirical Analysis of Cointegration and VEC Model

**Wen YAO** *

Department of Business and Trade, Southwest University Rongchang Campus, Chongqing 402460, China

**Abstract** The expanded agricultural trade deficit in recent years has caused widespread concern about the international competitiveness of Chinese agricultural products. In this paper, guided by Michael Porter's diamond model theory, based on agricultural production and trade data in China and the world from 1986 to 2011, we use principal component analysis, cointegration and vector error correction model, to perform an empirical analysis of the impact of agricultural modernization, economic growth and industrialization on the international competitiveness of Chinese agricultural products. The results show that China's agricultural modernization is slow, the demand for agricultural products caused by economic growth is increased, and excessive rural labor transfer due to industrialization leads to decline in the international competitiveness of Chinese agricultural products. China should increase its efforts to promote the modernization of agriculture and level of industry nurturing agriculture; use WTO rules to create a good international and domestic environment for the development of China's agriculture and improvement of the international competitiveness of agricultural products; give full play to the role of demand in boosting the industrial upgrading of domestic agriculture.

**Key words** Agricultural modernization, Economic growth, Industrialization, International competitiveness of agricultural products, VEC model

## 1 Introduction

Since the beginning of the new century, China's agricultural trade deficit has become increasingly larger. The import of agricultural products to some extent ensures the domestic supply of agricultural products and graces consumer's tables, but long-term large trade deficit means that the domestic market is occupied by foreign agricultural products, which will trigger a series of problems. How to reverse this unfavorable situation is an important issue to be solved. With trade liberalization progresses and gradual internationalization of the market, the non-economic factors in competition gradually give way to economic factors, and industrial international competitiveness has become a major factor affecting imports and exports. The national industrial international competitiveness of Chinese agricultural products shows a downward trend (Liu Linqing *et al.*, 2011), suppressing the growth of China's agricultural exports (Li Yueyun *et al.*, 2007). What factors influence or even determine the international competitiveness of Chinese agricultural products? In addition, the 18th National Congress of the Communist Party of China proposed the development strategy of "new four modernizations", and agricultural modernization and industrialization will be the long-term trend of China's economic and social development. What kind of influence they impose on the international competitiveness of Chinese agricultural products? This article will use the diamond model theory for explanation and perform the empirical analysis to answer these questions.

## 2 Literature review

The diamond model is an economic model developed by Michael Porter in his book *The Competitive Advantage of Nations*, where he published his theory of why particular industries become competitive in particular locations. Afterwards, this model has been expanded by other scholars. The approach looks at clusters, a number of small industries, where the competitiveness of one company is related to the performance of other companies and other factors tied together in the value-added chain, in customer-client relation, or in local or regional contexts. The Porter analysis was made in two steps. First, clusters of successful industries have been mapped in 10 important trading nations. In the second, the history of competition in particular industries is examined to clarify the dynamic process by which competitive advantage was created. The second step in Porter's analysis deals with the dynamic process by which competitive advantage is created. The basic method in these studies is historical analysis. The phenomena that are analyzed are classified into six broad factors incorporated into the Porter diamond, which has become a key tool for the analysis of competitiveness. The theory fully reveals the sources and influencing factors of international competitiveness, greatly enhancing the ability to explain the phenomenon of international competition. In recent years, scholars have conducted a lot of researches on the

Received: October 22, 2014 Accepted: December 27, 2014

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

* Corresponding author. Email: y605@163.com

international competitiveness of agricultural products under the guidance of this theory. Hobbs, J. E. *et al.* (1998) analyze the international competitiveness of the Danish pork from the point of view of the supply chain, and point out that the Danish pork production cooperatives have advanced slaughtering technology and the processing technology is the reason for the strong international competitiveness of pork. J. Wijnands (2001) analyzes the international competitiveness of tomatoes, peppers and cucumbers in the Netherlands and Spain, and believes that the advantages of the Netherlands lie in the performance and effectiveness of the supply chain while the advantages of Spain lie in market-oriented product quality. Shuai Chuanmin *et al.* (2003) maintain that poor export structure and single market structure are the main factors restricting the improvement of the international competitiveness of Chinese agricultural products. Ruan Yin (2008) argues that the major obstacle to improvement of international competitiveness of Chinese traditional medicine industry is the problem of government, enterprises and market itself. Deng Qiming *et al.* (2011) propose the implementation of protection of geographical indications based on a survey of Zhejiang and Fujian in order to enhance the international competitiveness of agricultural products. Zhou Hao (2011) proposes strengthening the fight against trade partners' abuse of anti-dumping rights, in order to maintain and improve China's international competitiveness of agricultural products. Liao Yi and Zhou Faming (2012) believe that the domestic production, export prices, RMB exchange rate, brand and technology have a significant impact on the international competitiveness of Chinese tobacco and its products. From the existing literature, scholars have studies the international competitiveness of agricultural products in China, but the above literature is mostly limited to qualitative analysis. As put by Michael Porter (1990), there are multifarious factors affecting the international competitiveness. In view of this, under the guidance of Michael Porter's diamond model theory, this paper performs the empirical research on the international competitiveness of agricultural products in China from the perspectives of factors of production, demand conditions, and performance of related industries and supporting industries.

## 3 Methods and data

### 3.1 Variable selection

**3.1.1** The international competitiveness of agricultural products. In this paper, this paper uses Trade Competitiveness Index (TCI) to measure the international competitiveness of Chinese agricultural products. Trade Competitiveness Index (TCI) was developed by Grubel and Lloyd (1975) to reflect the international division of labor. The value range of TCI is (−1, 1). $TCI_i \to -1$ means that the export competitiveness of industry i is very weak; $TCI_i \to 0$ means that the productivity of industry i is close to the international level; $TCI_i \to 1$ means that the export competitiveness of industry i is very high. From the dynamic point of view, if this coefficient rises, the competitive advantage of this commodity will expand; if the coefficient falls, the dynamic competitive disadvantage will expand. Based on agricultural trade, TCI is calculated as follows:

$$TCI_{ac} = \frac{X_{ac} - M_{ac}}{X_{ac} + M_{ac}} \quad (1)$$

where $X_{ac}$ represents China's agricultural exports; $M_{ac}$ represents China's agricultural imports.

**3.1.2** Factors of production. The factors of production in the diamond model theory include human resources, natural resources, knowledge resources, capital resources, and infrastructure. The "factors of production" can reflect the level of agricultural modernization in a country. Different scholars use different methods to measure the level of agricultural modernization. Xia Chunping et al. (2010) use the level of agricultural modernization to measure the level of agricultural modernization in a country or region. Wang Bei (2012) uses labor productivity in the agricultural sector to measure the level of agricultural modernization in China. Wang Xuezhen et al. (2005) think that the indicators reflecting 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 power of agricultural machinery per unit area of arable land. Wu Xuxiao (2012) considers that the indicators reflecting the level of agricultural modernization include agricultural land productivity, per capita disposable income of farmers, agricultural labor productivity, total power of agricultural machinery. However, the above measurement methods ignore agricultural laborers' scientific and cultural qualities on agricultural modernization, and it is not accurate to use factor input per unit area of arable land to measure the level of agricultural modernization. In view of this, this paper measures the level of a country's agricultural modernization from agricultural mechanization, infrastructure building, modern agricultural science and technology, environmental optimization and well-educated practitioners, as shown in Table 1. This paper also uses principal component analysis to integrate the above indicators into one comprehensive evaluation indicator for agricultural modernization (hereinafter abbreviated as "M"), and the calculation steps are summarized as follows: first, calculate the pretreated correlation matrix of the sample (R); second, calculate the eigenvalues and variance contribution rate of matrix R; third, calculate the eigenvector α that the eigenvalue corresponds to; fourth, calculate the product of square root of the eigenvalues and corresponding eigenvectors to derive the factor loading; fifth, calculate the product of original matrix X and principal component eigenvector α to derive the comprehensive indicator of agricultural modernization.

**3.1.3** Demand conditions. Economic growth will increase spending power, and this paper uses residents' per capita consumer spending level (RJXF) as the descriptive variable for domestic agricultural demand factor. It is calculated as follows:

Per capita consumer spending (RJXF) = urban per capita consumer spending × urbanization rate + rural per capita consumer spending × (1 − urbanization rate) (2)

**Table 1 Indicators of agricultural modernization**

| First level indicators | Descriptive indicators |
|---|---|
| Mechanization of agricultural production | The total power of agricultural machinery ($M_1$) |
| Infrastructure building | Effective irrigated area ($M_2$) |
| | Dike protecting area ($M_3$) |
| Modern agricultural science and technology | Fertilizer use in agricultural production ($M_4$) |
| | Mulching area ($M_5$) |
| Ecological optimization | Soil erosion control area ($M_6$) |
| Well-educated practitioners | Education level of rural labor ($M_7$) |

**3.1.4** Performance of related industries and supporting industries. Non-agricultural industries provide material technical support and services to agriculture. Therefore, this paper uses the level of industrialization (GYH) to describe the performance of related industries and supporting industries. It is calculated as follows:

Level of industrialization (GYH) = output value of secondary and tertiary industries/GDP (3)

**3.2 Cointegration and VEC model** In statistics, ordinary least squares (OLS) or linear least squares is a method for estimating the unknown parameters in a linear regression model, with the goal of minimizing the differences between the observed responses in some arbitrary dataset and the responses predicted by the linear approximation of the data. The resulting estimator can be expressed by a simple formula, especially in the case of a single regressor on the right-hand side. A basic assumption of OLS method is stationary economic variable. However, in empirical studies, most macroeconomic variables are non-stationary, and using OLS method for non-stationary economic variables may produce "spurious regression". The cointegration method and error correction model (ECM) developed by Engle et al. (1987) use Wald statistic to test the significance of variable coefficients in ECM in order to judge the short-term or long-term causal relationship between the variables, thereby providing a new way of thinking for solving "spurious regression". Therefore, this paper takes cointegration and error correction model as the basic analysis tools. This paper uses Johansen cointegration to test whether there is cointegration relationship between the variables, and establishes VCE model on this basis to test the ability of long-term equilibrium relationship to adjust short-term fluctuations.

**3.3 Research hypothesis and model selection**

**3.3.1** Research hypothesis. According to Michael Porter's diamond model theory, the international competitiveness of an industry depends on the factors of production, demand conditions, performance of related and supporting industries, and business strategy and corporate structure. Since the reform and opening up, the ultra-small-scale family farm under the household contract system has been the basic unit of agricultural production, and despite the development of appropriate scale of operation, it does not become a mainstream mode of agricultural production in China (Zou Xinyue et al., 2003; Zhang Xinguang, 2011). Therefore, in order to facilitate research, this article assumes that the corporate strategy does not change significantly in the study period.

**3.3.2** Model selection. As mentioned above, according to Porter's diamond model theory, the international competitiveness of a country's particular industry can be expressed as the following function:

$$y = f(x_1, x_2, x_3, x_4) \quad (4)$$

where $y$ is the international competitiveness; $x_1$ is the factors of production; $x_2$ is the demand conditions; $x_3$ is the performance of related industries and supporting industries; $x_4$ is the business strategy.

According to this research hypothesis, the international competitiveness of agricultural products can be expressed as the following function:

$$y = f(x_1, x_2, x_3) \quad (5)$$

According to the above variables, formula (5) can be further simplified as follows:

$$TCI = f(M, RJXF, GYH) \quad (6)$$

In order to eliminate heteroscedasticity, this paper builds the following semi-logarithmic econometric analysis model:

$$TCI_t = \alpha + \beta_1 M_t + \beta_2 \ln RJXF_t + \beta_3 GYH_t + \varepsilon_t \quad (7)$$

where $\varepsilon_t$ is the random disturbance term.

To test the ability of long-term equilibrium relationship to adjust short-term fluctuations, Engle and Granger combine cointegration with error correction model to establish vector error correction model. VEC model contains cointegration constraints, and it is more used in the modeling of non-stationary time series with cointegration relationship. VEC model is established as follows:

$$\Delta y_t = \alpha ECM_{t-1} + \sum_{i=1}^{p-1} \beta_i \Delta y_{t-i} + \sum_{i=1}^{p-1} \gamma_i \Delta y_{t-i} + \varepsilon_t \quad (8)$$

where $y$ is the endogenous dependent variable ($TCI$); ECM is the error correction term; $p$ is the lag order of VAR model, and the lag order is $p-1$; $x$ is the exogenous variable ($M$, $LNRJXF$ and $GYH$); $\varepsilon$ is the information term.

**3.4 Sample data selection, data sources and processing**

**3.4.1** Sample data selection and data sources. Because of the availability of data, this paper selects the agricultural production and trade data in China and the world from 1986 to 2011 as the basic data for the study. The data of China's agricultural production, per capita consumption expenditure and consumer price index are from *China Rural Statistical Yearbook* and *China Statistical Yearbook* (1987 − 2012). The agricultural product trade data of

China and the world are from the WTO database (http://stat.wto.org/Statistical Program).

**3.4.2** Data processing. (i) Education level of rural labor. The education level data are measured based on years of education. Traditional calculation formula is as follows:

$$M_{it} = \sum_{i=1}^{n} L_{it} h_i \quad (9)$$

where $M_{it}$ is the total educational attainment in year $t$; $L_{it}$ is the number of employees with education level $i$ in year $t$; $h$ is the length of education enjoyed for education level $i$.

To avoid the simple homogeneous summation of years of schooling, the current reasonable solution is Schultz's method of years of education, and it is calculated as follows:

$$M_{it} = \sum_{i=1}^{n} L_{it} h_i S_i \quad (10)$$

where $S_i$ is the contribution rate of various levels of educational attainment.

For the division of years of education, based on the approach of Song Yingjie (2010), the years of education, corresponding to $h_1 - h_5$, are determined as follows: illiterate and semi-literate 1; primary school 7; junior high school 10; senior high school 13; college 18. For $S_i$, based on the actual situation of China's rural development characteristics of data acquisition, this paper uses the measuring data of Zhou Xiao et al. (2003) to determine $S_i$, corresponding to $S_1 - S_5$, as follows: illiterate and semi-literate 1; primary school 1.070; junior high school 1.254; senior high school 1.308; college 1.634. Meanwhile, in order to avoid the interference caused by different units of secondary indicators, this paper uses the approach of Zhang Weihua and Zhao Mingjun (2005) to take the natural logarithm of these data and use mean method for dimensionless processing. (ii) Per capita consumption expenditure. This paper uses the national consumer price index (CPI, 100 in 1986) to exclude the inflation factors in urban and rural residents' per capita consumption expenditure.

## 4 Measurement results and interpretation

### 4.1 Correlation index calculation

**4.1.1** Calculation of the level of agricultural modernization. Using SPSS16.0 software, we perform the principal component analysis of $M_1 - M_7$, and KMO statistic is 0.847. Bartlett's test of sphericity $x^2$ = 534.389, P = 0.000, so it is suitable for principal component analysis. Principal component analysis 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 | 6.593 | 0.351 | 0.035 |
| Contribution rate | 0.94179 | 5.011 | 0.493 |
| Cumulative contribution rate | 0.94179 | 0.99190 | 0.99684 |

Table 2 shows that the eigenvalues of the first principal component and second principal component are 6.593 and 0.351, respectively, and the contribution rate of the first principal component reaches 0.94179, indicating that the first principal component contains the 94.179% of information of the original seven indicators. According to the factor extraction principle of eigenvalues greater than 1, we extract the first principal component to replace the original seven indicators. The eigenvectors of the first principal component can be shown in Table 3.

**Table 3 The eigenvectors of the first principal component**

| Eigenvectors | The total power of agricultural machinery ($M_1$) | 0.151 |
|---|---|---|
| | Effective irrigated area ($M_2$) | 0.150 |
| | Dike protecting area ($M_3$) | 0.131 |
| | Fertilizer use in agricultural production ($M_4$) | 0.149 |
| | Mulching area ($M_5$) | 0.148 |
| | Soil erosion control area ($M_6$) | 0.151 |
| | Education level of rural labor ($M_7$) | 0.151 |

We get the following principal component evaluation model:

$$F = 0.151M_1 + 0.150M_2 + 0.131M_3 + 0.149M_4 + 0.148M_5 + 0.151M_6 + 0.151M_7 \quad (11)$$

where $F$ is the level of agricultural modernization (M).

**4.1.2** Calculation of TCI index, per capita consumer spending level and industrialization level. According to equation (1), (2) and (3), we use the agricultural production and trade data of China and the world to calculate the TCI index, per capita consumer spending level and industrialization level.

**4.2 Unit root test** Using the cointegration theory, we first conduct an empirical test on whether there is integrated of the same order for the variables. In this paper, we use the currently widely used ADF unit root test method to conduct the unit root test of time series TCI, M, LnRJXF and GYH, and the results are shown in Table 3. It indicates that at the 5% significance level, the time series M, LnRJXF, GYH and TCI are integrated of the same order, meeting the prerequisites for cointegration analysis.

**Table 3 Unit root test results of time series TCI, M, LNRJXF and GYH**

| Variables | Testing variables | Test form (c,t,k) | ADF statistic | The critical value 1% | The critical value 5% | Order of integration |
|---|---|---|---|---|---|---|
| *TCI* | Original value | (c,t,1) | −3.343691 | −4.394309 | −3.612199 | I(1) |
| | The first order difference | (c,0,1) | −5.245873 | −3.752946 | −2.998064 | |
| *M* | Original value | (c,t,0) | −1.266214 | −4.374307 | −3.603202 | I(1) |
| | The first order difference | (c,0,0) | −5.448884 | −3.737853 | −2.991878 | |
| *LnRJXF* | Original value | (c,t,2) | −2.887349 | −4.374307 | −3.603202 | I(1) |
| | The first order difference | (c,t,0) | −4.193994 | −4.394309 | −3.612199 | |
| *GYH* | Original value | (c,t,1) | −2.228003 | −4.394309 | −3.612199 | I(1) |
| | The first order difference | (c,0,0) | −4.398247 | −3.737853 | −2.991878 | |

Note: *c* and *t* in test form denote the constant term and trend term, respectively, and *k* is lag order; ADF test critical value is from the software Eviews 6.0; lag *k* is selected automatically by the software according to the SC Information Criterion.

**4.3 Johansen cointegration test** Before using VEC model for analysis, there is a need to test whether there is cointegration relationship between the relevant variables. In this paper, we perform the Johansen cointegration test on variable series M, LnRJXF, GYH and TCI, and the results are shown in Table 4, 5.

**Table 4 Johansen test results of variables**

| Null hypothesis: number of cointegration vector | Characteristic root | Maximum eigenvalue statistic | 0.05% critical value | P value |
|---|---|---|---|---|
| None * | 0.7529 | 33.5511 | 28.58808 | 0.0106 |
| At most 1 | 0.592448 | 21.54207 | 22.29962 | 0.0635 |

Note: * indicates rejecting the null hypothesis at the 5% level.

**Table 5 Cointegration vector normalized**

| TCI | M | LnRJXF | GYH | C |
|---|---|---|---|---|
| 1.000000 | −1.245625 | 0.639154 | 20.44872 | −21.0169 |
| | (−0.28677) | (−0.23937) | (−3.64185) | (−3.75778) |
| | [4.3436378] | [−2.6701508] | [−5.61493] | [5.592893] |

Note: Data in parenthesis is the standard error, and the data in square brackets is the t statistic.

The eigenvalues statistic rejects the null hypothesis that the number of cointegration vector is zero at the 5% significance level, indicating that in the sample interval, there is a cointegration relationship among the time series TCI, M, LnRJXF and GYH, and there is one sole cointegration vector among the four at the 5% significance level. In accordance with the test results, we can get the cointegration equation of impact of agricultural modernization (M), per capita consumption level (LnRJXF) and industrialization level (GYH) on the international competitiveness of agricultural products (RCA) as follows:

$$RCA = 1.25M - 0.64 ln RJXF - 20.45GYH + 21.02 \quad (12)$$

**4.4 Granger causality test** The cointegration test can only show the existence of a long-term stable equilibrium relationship between the variables, but it can not determine whether this relationship is causal (Toda et al., 1995). Therefore, we use Granger causality test method under non-stationary series to test whether agricultural modernization (M), economic growth (LnRJXF) and industrialization (GYH) are the cause of changes in the international competitiveness of agricultural products (TCI). The Granger causality test results of M, LnRJXF, GYH and TCI are shown in Table 6. Obviously, at the 5% significance level, agricultural modernization (M), economic growth (LnRJXF) and industrialization (GYH) are the cause of the international competitiveness of agricultural products (RCA).

**Table 6 Granger causality test results of M, P, O and RCA**

| Null hypothesis | Lag | Obs | F value | P value | Conclusions |
|---|---|---|---|---|---|
| M does not Granger cause TCI | 2 | 24 | 4.22109 | 0.0304 | Rejected |
| TCI does not Granger cause M | 2 | 24 | 0.19634 | 0.8234 | Not rejected |
| LnRJXF does not Granger cause RCA | 2 | 24 | 8.94387 | 0.0018 | Rejected |
| RCA does not Granger cause LnRJXF | 2 | 24 | 0.31804 | 0.7314 | Not rejected |
| GYH does not Granger cause TCI | 2 | 24 | 6.58383 | 0.0067 | Rejected |
| TCI does not Granger cause GYH | 2 | 24 | 0.84878 | 0.4435 | Not rejected |

**4.5 VEC model** To test the ability of long-run equilibrium relationship between the international competitiveness of agricultural products (TCI) and agricultural modernization (M), economic growth (LnRJXF), industrialization (GYH) to adjust the short-term fluctuations, this paper builds the VEC model of the international competitiveness of agricultural products (TCI) to agricultural modernization (M), economic growth (LnRJXF) and industrialization (GYH). The lag order selection criteria are shown in Table 7.

**Table 7 Lag order selection criteria**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 104.7299 | NA | 8.01e-10 | -9.593321 | -9.394364 | -9.550142 |
| 1 | 216.1800 | 169.8288 | 9.38e-14 | -18.68381 | -17.68903 | -18.46792 |
| 2 | 230.8593 | 16.77626 | 1.30e-13 | -18.55803 | -16.76742 | -18.16942 |
| 3 | 257.8051 | 20.53014 | 8.33e-14 | -19.60048 | -17.01405 | -19.03916 |
| 4 | 328.5509 | 26.95079* | 2.46e-15* | -24.81437 | -21.43211 | -24.08033 |
| 5 | 2094.026 | 0.000000 | NA | -191.4310* | -187.2529* | -190.5243* |

As can be seen from the above table, when the lag order is 5, it is necessary to build the VAR model with lag order of 5, so this paper builds the VEC model with lag order of 4 (excluding item not significant). The results are shown in the following formula (13):

$$\Delta TCI_t = -0.51ECM_{t-1} - 0.47\Delta TCI_{t-2} - 0.48\Delta M_{t-2} - 0.37\Delta M_{t-4} + 0.84\Delta \ln RJXF_{t-2} + 0.09\Delta \ln RJXF_{t-3} + 6.37\Delta GYH_{t-1} + 6.16\Delta GYH_{t-2} - 0.49 \quad (3)$$

$$(-10.15) \quad (-7.38) \quad (-4.55) \quad (-2.10) \quad (-4.43) \quad (2.89) \quad (5.39) \quad (9.06) \quad (7.11)$$

$$[0.00] \quad [0.03] \quad [0.03] \quad [0.04] \quad [0.00] \quad [0.01] \quad [0.02] \quad [0.00] \quad [0.00]$$

Note: Figures in parentheses are t statistics, and figures in brackets are $P$ values.

**4.6 Results and explanation** From the cointegration equation and vector error correction model, agricultural modernization has a long-term positive impact on the international competitiveness of agricultural products in China, and economic growth and industrialization have a long-term negative impact on the international competitiveness of agricultural products in China. The coefficients of error correction term reflect the adjustment of deviation from the long-term trend, and when the international competitiveness of agricultural products in China deviates from long-term trends and encounters short-term fluctuations for some reason, the non-equilibrium state is brought back to equilibrium with (-0.51) adjustment intensity. Possible explanations include the following aspects: (i) The agricultural modernization can improve the material and technical equipment level of China's agriculture, thereby increasing agricultural productivity and enhancing the international competitiveness of Chinese agricultural products. (ii) The economic growth will increase domestic consumers' incomes, resulting in a growing domestic demand for agricultural products. More agricultural products are directly or indirectly consumed by domestic consumers but not for export, and it stimulates the imports of foreign high-end products to meet domestic consumers' extravagant consumption. (iii) The trade protectionism and unequal market openness between China and the major agricultural trading partners, have inhibited the role of growing domestic demand for agricultural products in boosting agriculture. (iv) China once long implemented the national development strategy of giving priority to heavy industry, and the system was designed to force agriculture to provide capital, land, labor and intellectual resources to industry, while industry offered little support for agriculture. (v) The rapid advance of industrialization has caused transfer of a lot of rural labor to cities and non-agricultural industries. The labor costs rise, and the competitive advantage in labor-intensive agricultural products has been gradually weakened, inhibiting the export of Chinese agricultural products to some extent.

## 5 Conclusions and policy recommendations

**5.1 Conclusions** The agricultural modernization has a significant positive effect on the international competitiveness of Chinese agricultural products, and the increasing consumption due to economic growth and industrialization have a significant negative effect on the international competitiveness of Chinese agricultural products. The slow China's agricultural modernization, increasing consumer demand for agricultural products and excessive transfer of rural labor have reduced the international competitiveness of Chinese agricultural products, leading to expanding agricultural trade deficit.

**5.2 Policy recommendations**

**5.2.1** Further promoting agricultural modernization building. It is necessary to increase subsidies for farmers to purchase agricultural machinery and improve the level of agricultural mechanization; increase investment in agricultural infrastructure, strengthen soil erosion control and optimize the ecological environment for agricultural production; increase R & D of modern agricultural science and technology and continuously improve farmers' scientific and cultural qualities; innovate upon the agricultural management system and enhance market responsiveness of agricultural production.

**5.2.2** Increasing the level of industry nurturing agriculture. It is necessary to deepen reform and redesign system to guide industry to provide the necessary factors of production for agriculture, and promote the transformation of Chinese agriculture from traditional agriculture to modern agriculture.

**5.2.3** Making full use of WTO rules and giving full play to the role of demand in boosting the industrial upgrading of domestic agriculture. It is necessary to oppose trade protectionism, trade partners' abuse of anti-dumping and all kinds of trade barriers damaging the principles of free trade, and promote the equal market openness between trading partners. At the same time, it is necessary to make full use of the legitimate rights and interests stipulated in WTO rules for the developing countries, and moderately protect the domestic agricultural production.

## References


[1] Balassa B. , Exports and economic growth: further evidence[J]. Journal of Development Economics, 1978 (5): 181 -189.

[2] Grubel H. G. and P. J. Lloyd. Intra-industry trade: the theory and measurement of international trade in differentiated products[M]. New York: John Wilely, 1975.

[3] Engle, Robert F. , C. W. J. Granger. Co-integration and error correction: Representation, estimation and testing[J]. Econimetrica, 1987, 55:251 -276.

[4] Hobbs J. E. , Kerr W. A. , Klein K. K. Creating international competitiveness through supply chain management: Danish pork[J]. Supply Chain Management: An International Journal, 1998, 3(2):68 -78.

[5] Porter M. E. The competitive advantage of nations[M]. New York (NY): Free Press, 1990.

[6] Toda H. , T. Yamamoto. Statistical inference in vector autoregressions with possibly integrated processes[J]. Journal of Econometrics, 1995(66):225 -250.

[7] Wijnands J. The International Competitiveness of Fresh Tomatoes, Peppers and Cucumbers[C]. In International Congress on Greenhouse Vegetables. The Production Chain of Fresh Tomatoes, Peppers and Cucumbers, D. Cantliffe. 2003: 79 -90.

[8] DENG QM, ZHU DP, DONG XY, *et al*. Study on geographical indication protection, dominant industrial development and international competitiveness of agricultural products——Based on the investigation and analysis of Zhejiang and Fujian Provinces[J]. Problems of Agricultural Economy,2011(9):47 -52. (in Chinese).

[9] JIANG TT, WU XG. A study on the evaluation model of the cultural industry competitiveness based on AHP——By borrowing diamond model theory and sustainable development thinking[J]. Journal of Yunnan Finance and Trade Institute,2011(6):126 -134. (in Chinese).

[10] LI YY, WU YY, ZHAO M. Review of China's agricultural products trade and study on the change of international competitiveness of China's agricultural products after entering WTO[J]. Journal of International Trade,2007(8):67 -72. (in Chinese).

[11] LIAO Y, ZHOU FM. Analysis on international competitiveness of Chinese tobacco and tobacco products and its influencing factors[J]. Journal of International Trade,2012(3):22 -33. (in Chinese).

[12] LIU LQ, ZHOU L. Comparative advantage, FDI and international competitiveness of China's agricultural products industry[J]. Journal of International Trade,2011(12):39 -54. (in Chinese).

[13] RUAN Y. Analysis on international competitive advantage of China's traditional Chinese medicine industry based on competitive superiority theory[J]. Heilongjiang Foreign Economic Relations and Trade,2008(6):12 -13. (in Chinese).

[14] SONG YJ. Empirical study on the relationship between income and their extent of education——Based on provincial panel data[J]. Journal of Agrotechnical Economics,2010(10):50 -57. (in Chinese).

[15] SHUAI CM, CHENG GQ, ZHANG JL. The estimation of international competitiveness of Chinese agricultural products[J]. Management World, 2003(1):97 -103. (in Chinese).

[16] WANG B. Empirical study on the relations between industrialization, urbanization and agricultural modernization[J]. Urban Problems,2011(9):21 -25. (in Chinese).

[17] WANG XZ, GAO F, WANG JT. The agricultural modernization and its development with international interaction in the Eastern Shandong Province[J]. Problems of Agricultural Economy,2005(5):8 -13. (in Chinese).

[18] WU XX. Research on coordinative development of urbanization, industrialization and agricultural modernization in central region of China Jiangxi, Hunan, Hubei and Henan as examples[J]. Research of Agricultural Modernization,2012,33(1):1 -7. (in Chinese).

[19] XIA CP, LU WZ. An analysis on realistic conditions of the coordination of industrialization, urbanization and agricultural modernization[J]. Economic Review,2010(8):61 -63. (in Chinese).

[20] ZOU XY, XIAO GA. Game analysis for agricultural small-size management patterns in China[J]. China Rural Survey,2003(5):18 -23. (in Chinese).

[21] ZHANG WH, ZHAO MJ. The influence of undimensionalization on the reliability of comprehensive evaluation results and an empirical analysis[J]. Statistics & Information Tribune,2005,20(3):33 -36. (in Chinese).

[22] ZHANG XG. Study on political implications and realistic concerns of small peasant economy theory[J]. Problems of Agricultural Economy,2011(1):81 -88. (in Chinese).

[23] ZHOU H. Study on international competitiveness of agricultural products and the countermeasures based on anti-dumping in China[J]. Modernization of Management,2011(6):47 -49. (in Chinese).

[24] ZHOU X, ZHU N. Return to human capital in rural China[J]. Chinese Journal of Population Science,2003(6):17 -2. (in Chinese).