The Influence of Agricultural Mechanization on the Development of Agricultural Economy in Chongqing City

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Abstract The impact of the agricultural mechanization development on the agricultural economy has caught public attention. In this paper, the role of the agricultural mechanization in the agricultural economic development of Chongqing is analyzed with the qualitative and quantitative methods based on econometrics and agricultural engineering theory, and its contribution rate is 30.6%. Moreover, the development of agricultural mechanization of the agricultural economy will play a leading role in the 21st century, and will change the traditional economic development mode featured by increasing agricultural labor and chemical fertilizer. The quality and quantity of agricultural labor force mastering modern science technology is the key to the development of modern agricultural economy.

Key words Agricultural mechanization, Agricultural economy, Contribution rate, Empirical study

1 Introduction

Technology not only penetrates into production process as a factor of production, but also has great influence on all aspects of social life. It becomes an important symbol of human civilization [1]. Contemporary China's rural economy will inevitably develop towards modernization, industrialization and specialization, and agriculture is increasingly big on intensive development. The corresponding adjustment of the agricultural structure is gradually linked to saving-oriented and efficient agricultural construction which is based on science and technology and agricultural machinery. Through the development of industrialization and mechanization, it can effectively improve agricultural productivity and promote the rapid development of scale agricultural land operation, rural economy and improvement of farmers' living standards, so it is inevitably inseparable from the development and promotion of modern agricultural mechanization technology. Based on the data of rural economic development since the establishment of Chongqing Municipality, this paper uses econometrics and agricultural engineering to analyze and study the influence of agricultural mechanization on the development of agricultural economy from a quantitative point of view.

2 Literature review

The economic growth issues have attracted close attention since 1776, while the modern theory of economic growth is the first significant progress based on the Solow growth model developed in 1956. In the mid-1980s, started by the works of Romer (1986) and Lucas (1988), the research on issues of economic growth once again achieved major progress and development. The study of the impact of agricultural mechanization on rural economic development is mainly reflected in three aspects. (i) The contribution of agricultural mechanization to rural economic growth is not directly studied, but there are studies on the contribution of scientific and technological progress to economic growth from a macro perspective. The C-D production function, developed by the American mathematician Cobb and economist Douglas in 1927, and Solow growth model in 1956, are the typical cases. At home, there are also many research results, such as the classic by Lin Yifu Institution, *Technology and Agricultural Development in China* [2] and *A Review of Institution, Technology and Agricultural Development in China* [3], the work by Jiang Heping *et al.* (2001) *Measurement and Analysis on Contribution Rate of the National Agricultural Technology Progress during* 1995 – 1999 [4], the work by Zhu Xigang *Agricultural Technology Progress and Estimation on Its Contribution during the Seventh Five-Year Plan Period* [5], and the work by Li Xingguo *et al. Research and Application of Calculation Method for Technology Progress Contribution Rate* [6]. (ii) The calculation methods for the contribution of agricultural mechanization to agricultural production are analyzed and compared. In *Study on the Calculation Method for the Contribution of Agricultural Mechanization to Agriculture*, Yang Bangjie *et al.* (2000) compare the Cobb-Douglass production function model method and "with or without comparison method" in terms of calculation steps and models [7]. (iii) From empirical aspect, a calculation method is used to analyze and explore the influence of agricultural mechanization on agricultural output, farmers' income increase or farming development. Feng Haifa uses composite index to measure the total factor productivity of agriculture in China [8]. *Study on China's Comprehensive Agricultural Production Capacity* edited by the Research Office of the State Council uses data envelopment analysis to measure the contribution of factor inputs to farming output value and employs C-D production function to estimate the contribution of factor inputs to animal husbandry and fishery output value [9].

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3 Overview of rural economic development in Chongqing City

Since Chongqing became a municipality under the central government in 1997, there has been rapid social and economic development, and GDP was higher than the national average, increasing from 136.024 billion yuan in 1997 to 652.872 billion yuan in 2009, an annual average growth rate of over 20%. The rural living standards have been greatly improved, and the per capita net income increased from 1638.2 yuan in 1997 to 3907.16 yuan in 2008. The rural economic aggregate also continued to grow, and the output value of farming, forestry, animal husbandry and fishery increased from 43.935 billion yuan in 1997 to 87.139 billion yuan in 2008. Farming output value increased from 26.789 billion yuan in 1997 to 46.547 billion yuan in 2008, an average annual increase of 6.15%; forestry output value increased from 1.173 billion yuan in 1997 to 2.934 billion yuan in 2008, an average annual increase of 5.41%; animal husbandry output value increased from 14.689 billion yuan in 1997 to 34.415 billion yuan in 2008, 2.3 times that in 1997; fishery output value increased from 1.284 billion yuan in 1997 to 2.115 billion yuan in 2008, an average annual increase of 5.39%. The remarkable rural economic development in Chongqing City can not be separated from the significantly improved rural and agricultural production conditions, as well as the greatly improved agricultural mechanization inputs (Table 1). It is noteworthy that the total power of agricultural machinery, agricultural irrigation and drainage machinery, agricultural pumps, number of farm vehicles and total agricultural output value show an increasing trend, but the use of agricultural tractors does not gradually increase but varies considerably. To more clearly explain the subtle relationship, there is a need to take into account the changes in agricultural output, agricultural labor use and per capita net income of rural residents (Table 2). It can be seen from Table 2 that a large number of agricultural tractors do not necessarily bring the continued growth of agricultural output per unit area, but possibly bring crowding-out effect.

Table 1 The use of agricultural machinery and total agricultural output value in Chongqing City during 1997-2008

Year	Total power of agricultural machinery 10^4 kw	The number of large and medium-sized agricultural tractors 10^4	The number of small tractors 10^4	Power of agricultural irrigation and drainage machinery 10^4 kw	The number of agricultural pumps//10^4	The number of power thresher//10^4	The number of farm vehicles 10^4	Total agricultural output value 10^8 yuan
1997	454.07	0.07	1.52	76.47	6.44	6.18	1.93	259.32
1998	506.64	0.19	1.56	74.46	7.82	7.95	2.22	256.00
1999	558.54	0.05	1.47	45.55	10.52	10.16	2.10	252.44
2000	586.47	1.01	1.49	85.21	22.83	12.47	2.28	255.96
2001	628.07	1.36	1.21	93.59	25.99	15.53	3.32	257.50
2002	665.57	0.25	1.00	99.44	29.58	18.99	3.62	272.68
2003	695.67	0.29	0.93	106.17	39.04	19.89	3.39	277.24
2004	728.31	0.27	0.84	115.07	52.43	24.76	3.25	329.53
2005	775.96	0.01	0.39	121.61	54.23	27.76	6.11	351.79
2006	820.01	0.06	0.43	126.09	56.31	35.89	6.11	309.72
2007	860.31	0.23	0.68	134.34	62.05	46.82	5.99	367.72
2008	903.15	0.26	0.69	144.48	76.34	54.30	6.01	403.70

Note: Data are from *Chongqing Statistical Yearbook* (1997 – 2009); the total agricultural output value is calculated with the price index in 1996 as the base period.

Table 2 The use of agricultural tractors and growth rate of agricultural output value in Chongqing City during 1997 – 2008

Year	Total power of agricultural machinery 10^4 kw	Growth rate of total power of agricultural machinery//%	The number of large and medium-sized agricultural tractors//10^4	The number of small tractors//10^4	The proportion of number of agricultural labor to total rural population//%	Growth rate of agricultural output value per unit area//%	Per capita net income of rural residents yuan
1997	454.07	10.77	0.07	1.52	40.40	4.25	1638.20
1998	506.64	11.58	0.19	1.56	40.05	-1.52	1808.69
1999	558.54	10.24	0.05	1.47	39.38	-0.79	1856.23
2000	586.47	5.00	1.01	1.49	38.60	1.44	1979.19
2001	628.07	7.09	1.36	1.21	37.88	1.59	2027.09
2002	665.57	5.97	0.25	1.00	36.52	8.69	2165.92
2003	695.67	4.52	0.29	0.93	35.28	6.51	2272.95
2004	728.31	4.69	0.27	0.84	34.68	14.41	2484.59
2005	775.96	6.54	0.01	0.39	33.79	6.48	2758.25
2006	820.01	5.68	0.06	0.43	33.00	-1.34	2755.65
2007	860.31	4.91	0.23	0.68	31.96	16.42	3214.17
2008	903.15	4.98	0.26	0.69	31.80	7.04	3578.57

Note: Data are from *Chongqing Statistical Yearbook* (1997 – 2009); the per capita net income of rural residents is calculated with the price index in 1996 as the base period.

4 Theoretical analysis and modeling

From the process of economic development in rural areas, the most direct role of agricultural mechanization is to increase agricultural productivity, thereby contributing to the rapid development of ru-

ral economy. It is worth noting that technological advances can promote rural economic development, and also improve the scientific and cultural level and labor skills of agricultural workers. Due to more advanced technical performance of agricultural machinery as well as the changes in power mechanism, input mechanism and service mechanism of agricultural machinery, the current agricultural machinery is better than the previous one in terms of quality and use efficiency [10]. Therefore, in order to better reflect the contribution of agricultural mechanization to agricultural economic growth in Chongqing City, based on Cobb-Douglass production function model, we establish an agricultural production model for quantitative analysis. By selecting agricultural labor, agricultural land, agricultural machinery and farm fertilizer use as explanatory variables, and agricultural output as the variable to be explained, we use the following agricultural production function to build economic model:

$$Y = F(X_1, X_2, X_3, X_4, T)$$

where Y is agricultural output; X_1 is agricultural labor; X_2 is agricultural land; X_3 is agricultural machinery; X_4 is farm fertilizer use; T is time variable.

Perform total derivative on the above formula:

$$dy = \frac{\partial y}{\partial x_1}dx_1 + \frac{\partial y}{\partial x_2}dx_2 + \frac{\partial y}{\partial x_3}dx_3 + \frac{\partial y}{\partial x_4}dx_4 + \frac{\partial y}{\partial T}dT \quad (1)$$

Divide both sides of formula (1) by Y:

$$\frac{dy}{y} = \frac{x_1}{y}\frac{\partial y}{\partial x_1}\frac{\partial x_1}{x_1} + \frac{x_2}{y}\frac{\partial y}{\partial x_2}\frac{\partial x_2}{x_2} + \frac{x_3}{y}\frac{\partial y}{\partial x_3}\frac{\partial x_3}{x_3} + \frac{x_4}{y}\frac{\partial y}{\partial x_4}\frac{\partial x_4}{x_4} + \frac{T}{y}\frac{\partial y}{\partial T}\frac{dT}{T} \quad (2)$$

For the technological advances in different periods, there is a need to take into account two consecutive periods in the analysis of problem, so we slightly process formula (2) and get the following formula:

$$\frac{\Delta y}{y} = \alpha_1\frac{\Delta x_1}{x_1} + \alpha_2\frac{\Delta x_2}{x_2} + \alpha_3\frac{\Delta x_3}{x_3} + \alpha_4\frac{\Delta x_4}{x_4} + \frac{1}{y}\frac{\partial y}{\partial T}\Delta T \quad (3)$$

where $\frac{\Delta y}{y}$ is agricultural output growth rate; $\frac{1}{y}\frac{\partial y}{\partial T}\Delta T$ is the rate of technological progress; $\alpha_1 = \frac{x_1}{y}\frac{\partial y}{\partial x_1}$ is the output elasticity of agriculture labor; $\frac{x_1}{y}\frac{\partial y}{\partial x_1}\frac{\Delta x_1}{x_1}$ is the output growth rate caused by increase in agricultural labor input.

The raising level of agricultural mechanization and technological progress will have some crowding-out effect on the rural labor force, that is, agricultural machinery has substitution effects on labor [11], so when examining the contribution of a factor of production to output growth, only considering the impact of this factor input change on output growth is partial. In real life, the output growth is composed of two parts: growth of a variety of input factors and growth of factor productivity. The output growth of a factor should include two parts, which can be expressed by the following formula:

$$\frac{\Delta y}{y} = \sum_{i=1}^{4}\beta_i\frac{\Delta x_i}{x_i} + \sum_{i=1}^{4}\beta_i\frac{\Delta p_i}{p_i} \quad (4)$$

where $\beta_i = \alpha_i / \sum_{i=1}^{4}\alpha_i$; $p_i = \frac{y}{x_i}$ (productivity of factor i); $\frac{\Delta p_i}{p_i} = \frac{\Delta y}{y} - \frac{\Delta x_i}{x_i}$ is the productivity growth rate of factor i.

From equation (4), we can get $\beta_i\frac{\Delta x_i}{x_i} + \beta_i\frac{\Delta p_i}{p_i} = \beta_i(\frac{\Delta x_i}{x_i} + \frac{\Delta y}{y} - \frac{\Delta x_i}{x_i}) = \beta_i\frac{\Delta y}{y}$, that is, β_i is the contribution rate of factor i to output growth [10].

5 Empirical analysis

This paper will use Cobb-Douglass production function to derive the general form of agricultural production function:

$$Y = Ae^{u}X_1^{\alpha_1}X_2^{\alpha_2}\cdots X_n^{\alpha_n} \quad (5)$$

where Y is the total agricultural output value; A, α_i ($i = 1, 2, \cdots, n$) are the parameters to be determined (set as constant to facilitate the calculation); u is the random interference term; A is the current level of technology; α_i ($i = 1, 2, \cdots, n$) is the output elasticity of factor of production; X_i is the input of various factors of production.

Take the logarithm on both sides of formula (5) and get the logarithmic linear model:

$$\ln Y = \ln A + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \cdots + \alpha_n \ln X_n + u$$

Taking into account the possibility of statistical data acquisition, the explanatory variable of agricultural production function in formula (5) is agricultural labor (X_1), and this data can not be obtained directly. To obtain data on agricultural labor, we conduct conversion according to the agricultural population, that is, it is weighted according to the share of total agricultural output value in total output value of farming, forestry, animal husbandry and fishery, consequently, it can make the labor input consistent with objects measured by output [12]. Agricultural land is denoted by total sown area of crops (X_2), and farm machinery can be denoted by total power of agricultural machinery (X_3). The data can be directly acquired from *Statistical Yearbook*; in addition, there is also a need to consider that crop output and agricultural chemical fertilizer application (X_4) is an important factor affecting agricultural output. The statistical data for various variables can be shown in Table 3.

According to equation (5), we determine the following function model:

$$\ln Y = \ln A + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3 + \alpha_4 \ln X_4 + u.$$

Based on the relevant data in Chongqing City from 1985 to 2008, we calculate the contribution of agricultural mechanization to agricultural output. Eviews 5.1 is used for model estimation, and the-re is first-order serial correlation in random disturbance term, so the generalized differential transformation is used for adjustment. We get the production function model as follows (t values in parentheses):

Table 3 Statistical data of Chongqing City from 1985 to 2008

Year	Total agricultural output value (Y) 10^4 yuan	Agricultural labor (X_1) //10^4	Crop sown area (X_2) //ha	Total power of agricultural machinery (X_3) //10^4 kw	Application rate of agricultural chemical fertilizer (X_4) (pure) //10^4 t
1985	249124	673.52	3214717	219.00	31.76
1986	258754	675.78	3232433	240.00	36.70
1987	255463	665.35	3241258	259.00	38.26
1988	235765	613.93	3287399	278.00	38.29
1989	222886	615.05	3381959	291.00	44.72
1990	270363	648.32	3438950	300.00	48.13
1991	278608	664.95	3526637	316.00	52.08
1992	269067	649.42	3522037	324.00	52.75
1993	278480	628.85	3513064	343.00	54.51
1994	285362	582.78	3493884	366.00	58.55
1995	360134	614.21	3526684	386.05	62.02
1996	404201	639.76	3585745	409.91	65.55
1997	392454	603.07	3605420	454.07	69.64
1998	395189	582.22	3614446	506.64	71.18
1999	401002	574.67	3592496	558.54	71.03
2000	411670	556.42	3590815	586.47	72.00
2001	425411	529.81	3555871	628.07	72.58
2002	453661	500.56	3464566	665.57	73.37
2003	466360	463.49	3307179	695.67	71.59
2004	566919	444.41	3435957	728.31	77.02
2005	618084	430.06	3444733	775.96	79.20
2006	548400	436.05	3073880	820.01	80.54
2007	657305	419.83	3134700	860.31	84.32
2008	725784	399.19	3215064	903.15	88.14

Note: Data are from *Chongqing Statistical Yearbook* (2009); the total agricultural output value is calculated with the price in 1985 as the base period.

$$\ln Y_t = \underset{(-3.319)}{-15.17666} + \underset{(2.227)}{0.373802}\ln X_{1t} + \underset{(3.886)}{1.138287}\ln X_{2t} + \underset{(3.405)}{0.945144}\ln X_{3t} + \underset{(-1.186)}{0.631818}\ln X_{4t} + \hat{u}_t$$

$$\hat{u}_t = \underset{(7.810)}{0.785277}\,\hat{u}_{t-1} + \varepsilon_t$$

$R^2 = 0.946$, $F = 77.87$, $D.W. = 1.86$.

The LM test is performed on the new residual series ε_t, and the test results are as follows:

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.077624	Prob. F(1,16)	0.784112
Obs * R-squared	0.111046	Prob. Chi-Square(1)	0.738957

From the fitting results of model, the overall effect of model is good ($R^2 = 0.946$, $F = 77.87$, passing the significance test at the 5% level). The output elasticity of agricultural labor, crop sown area, agricultural machinery and agricultural chemical fertilizer consumption is 0.373802, 1.138287, 0.945144 and 0.631818, respectively, and the elasticity coefficient is positive, indicating that the various factors have a positive impact on total agricultural output value, but there is a great difference in the elasticity coefficient of factors, indicating that these factors have different effects on agricultural output. From the elasticity analysis, there is a great difference in the role of various factors in increasing agricultural output. Crop sown area plays the largest role in increasing agricultural output, followed by the agricultural machinery and agricultural chemical fertilizer consumption. Agricultural labor plays the smallest role in increasing agricultural output, indicating that agricultural production is not largely dependent on labor input. According to formula (4), we can calculate the contribution of agricultural machinery to agricultural output:

$$\beta_3 = \alpha_3 / \sum_{i=1}^{4} \alpha_i \times 100\% \approx 30.60\%$$

Conspicuously, the role of agricultural mechanization in the development of agricultural economy can not be ignored especially in the current 21st century. We even must not cast a doubt on the role of agricultural machinery in improving people's living conditions and agricultural productivity.

6 Conclusions and recommendations

(i) In the science and technology and information era, agricultural mechanization will play a leading role in the development of agricultural economy, and continue to change the traditional extensive operation mode featured by the increase of agricultural labor and chemical fertilizer to promote the development of agricultural economy. (ii) The agricultural labor input has a small impact on agricultural output growth, and the quality and quantity of agricultural labor mastering modern science and technology is the key to development of modern agricultural economy. (iii) In the process of promoting agricultural modernization, it is necessary to avoid the blind dependence on the increase of large and medium-sized agricultural machinery, and choose reasonable matching combinations of various types of agricultural machinery in accordance with the local social and economic development and geographical conditions. Therefore, in the process of promoting agricultural modernization, industrialization and regional specialization in Chongqing

City, it is necessary to continue to increase learning and training of modern scientific knowledge for the rural labor, and constantly improve or accelerate the rural surplus labor transfer and rural land transfer.

References

[1] HUANG MX, LI JJ. Technology choice, upgrade of industrial structure and economic growth[J]. Economic Research Journal, 2009(7)143 - 151. (in Chinese).

[2] LIN YF. Institution, technology and a new exploration of agricultural development[M]. Shanghai: Shanghai People's Publishing House, 2005. (in Chinese).

[3] LIN YF. Re-discussion on institution, technology and a new exploration of agricultural development[M]. Beijing: Peking University Press, 2000. (in Chinese).

[4] JIANG HP, SU JC. Calculation and analysis of agricultural technology progress contribution ratio during the period of 1995 - 1999 in China[J]. Journal of Agrotechnical Economics, 2001(5):12 - 17. (in Chinese).

[5] ZHU XG. Analysis on the calculation of agricultural technical progress and its contribution portion during the seventh five-year plan[J]. Journal of Agrotechnical Economics, 1994(2):2 - 10. (in Chinese).

[6] LI XG, ZHANG LB. Research on the calculation method of contribution rate of scientific and technological progress[J]. Operations Research and Management Science, 1996, 5(4):41 - 44. (in Chinese).

[7] YANG BJ, HONG RB. Measuring research on the contributive rate of agricultural mechanization to the development of agricultural production[J]. Transactions of the Chinese Society of Agricultural Engineering, 2000, 16(3):50 - 53. (in Chinese).

[8] FENG HF. Evaluation on the efficiency of China agriculture——Theory, practice and method[M]. Beijing: China Agriculture Press, 1992. (in Chinese).

[9] Department of Agriculture, Research Office of the State Council. Study on the agricultural comprehensive productive capacity in China[M]. Beijing: China Agriculture Press, 1993. (in Chinese).

[10] CHENG ZQ, JIA SX. Theoretical analysis on the contributing ratio of agricultural mechanization to rural economy [J]. Transactions of the Chinese Society of Agricultural Engineering, 2001, 17(2):65 - 67. (in Chinese).

[11] LIU FQ. Study on the condition and effect of agricultural land scale operation:Taking the case of the northeast of China countryside[J]. Management World, 2006(9):71 - 79. (in Chinese).

[12] JIANG SA, SUN SM, GONG MB. The impact of land ownership structure on agricultural economic growth: An empirical analysis on agricultural production efficiency on the Chinese mainland (1949 - 1978)[J]. Social Sciences in China, 2005(3):38 - 47. (in Chinese).

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port of primary processing and secondary processing vegetables to deep processing vegetable varieties to increase the added value of China's vegetable exports. Thirdly, it is necessary to focus on vegetable export standardization in production, export, inspection and other aspects to prevent the non-tariff barriers to China's export of vegetables.

4.2.2 Further expanding the export scale of vegetables from China to ASEAN. Firstly, it is necessary to increase the import demand of the ASEAN countries. With the development of China-ASEAN Free Trade Area and improvement of economic level, China needs to study and weigh the situation, strengthen vegetable export to ASEAN, and prevent the position decline in the ASEAN vegetable market. Secondly, it is necessary to improve the ability to adjust export structure of vegetable varieties from China to ASEAN. China should gradually adjust the structural change in ASEAN's vegetable variety demand to meet constant market changes.

4.2.3 Strengthening agricultural trade cooperation with ASEAN and creating more favorable conditions. Through the establishment of free trade area, China and ASEAN have created more favorable conditions, which deepens the cooperation between China and ASEAN. In the framework of trade cooperation, in order to ensure the smooth development of vegetable export, the government should perform its duties to actively create export conditions, rationally use the rules, further develop the vegetable industries with competitiveness and comparative advantages, support the vegetable industries and enterprises with effect of scale economy, and increase investment in agricultural infrastructure.

4.2.4 Making full use of China-ASEAN Free Trade Area to create a better external environment. As the world economy continues to develop, China's vegetable exports to ASEAN has developed rapidly. Since the establishment of China-ASEAN Free Trade Area, China's vegetable exports to ASEAN have been significantly improved. On January 1, 2004, the implementation of Early Harvest Programme made the tariffs of most agricultural products exported from China to ASEAN fall to zero, and the export price of vegetables from China to ASEAN was further reduced. "Zero tariff" has greatly enhanced the export competitiveness of vegetables from China to ASEAN. China should make full use of the advantages of free trade zone to further expand the vegetable trade with ASEAN.

References

[1] AN YF, CHEN LF, SHENG LY. Study on the competitiveness of vegetable export from China to Japan[J]. Chinese Rural Economy, 2002 (11):25 - 29. (inChinese).

[2] CAI Y, LV MY, WANG K. International competitiveness of vegetable and its dominant varieties in China[J]. Journal of International Trade, 2007 (6):62 - 67. (in Chinese).

[3] JI L. Demand, structure, competitiveness and the vegetable export growth of China: An analysis based on revised CMS model[J]. International Economics and Trade Research, 2012, 28(9): 56 - 65. (in Chinese).

[4] LIU X. Study on international competitiveness of vegetable industry in China[D]. Beijing: China Agricultural University, 2002. (in Chinese).

[5] SHUAI CM, CHENG GQ. The estimation of the international competitiveness of Chinese agricultural products[J]. Management World, 2003 (1): 97 - 104. (in Chinese).

[6] SHI BZ. How does China become the first exporter [J]. Statistical Research, 2011, 28(5): 27 - 32. (in Chinese).

[7] WANG LH. International competitiveness of Chinese vegetables exports as illustrated by Sino - Japan trade dispute[J]. Journal of International Trade, 2002 (3): 20 - 24. (in Chinese).

[8] ZHANG QZ. The path selection of the competitiveness of Chinese agricultural products based on the comparative and comparative advantages[J]. Inquiry into Economic Issues, 2014 (5): 80 - 85. (in Chinese).

[9] BALASSA B. Trade liberalisation and "revealed" comparative advantage [J]. The Manchester School, 1965, 33(2): 99 - 123.