An Analysis of the Influence of Chinese Agriculture on National Economy and the Macroeconomic Effects

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Abstract As a basic industry, agriculture has a far-reaching impact on national economy. Based on input-output tables of China in 2005 and 2010, this paper gives a deep insight into the relationship between agriculture and national economy and its macroeconomic effects by the methods of input-output analysis, industrial correlation and macroeconomic effect analysis. The results show that the agricultural development is highly dependent on the national economy, but makes low contribution; agriculture contributes to promoting employment and improving the structure of national income distribution; despite the government's tax incentive, the agricultural equipments are updated slowly, and the corporate profits are at low level; agricultural export effect is far below the average industry level, but the import effect increases over the years, and final products are often used for domestic consumption. Finally, we set forth recommendations for improving the development of agriculture and national economy.

Key words Agricultural industries, National economy, Macroeconomic effects, Input-output analysis

1 Introduction

China is a large agricultural country, and the agricultural development is related to food security and overall economic development, so it is extremely important to understand the relationship between the agricultural development and national economy as well as the resulting macro impact, which can not only help us to further understand the importance and urgency of agricultural development, but also help us to find the constraints on the agricultural development. At present, domestic scholars conduct few studies on the correlation between Chinese agriculture and national economy, and they generally use the influence coefficient indicator and induction coefficient indicator. Geng Xianhui and Zhou Yingheng (2011) estimate that the influence coefficient of China's agricultural industry is 1.0162, slightly larger than 1, playing an obvious role in promoting the overall development of the national economy[1]. Wang Wei (2008) uses the comparative static analysis method to compare the influence of Chinese agriculture on national economy in 1992 and 2002, and the results show that the role of agriculture in national economy is gradually weakened[2]. Liu Heguang, Pan Qilong and Xie Sina (2012) adopt the idea of horizontal comparison to examine the intermediate inputs, full input, intermediate demand and influence of agriculture of China and USA in 2007, and conclude that due to different stages of development of agriculture and different position of agriculture in national economy between the two countries, there are significant differences in the industry linkage effect[3]. Xue Jiliang and Li Lutang (2011) analyze the relationship between agriculture and upstream and downstream industries of the production chain, and use input-output tables to measure the extent of the integration of China's agricultural industry, and the empirical results show that agriculture has the highest degree of forward integration in food industry, sewing and leather manufacturing, and the lowest degree of backward integration in food industry, chemical industry, transportation and posts and telecommunications[4]. The existing researches have discussed the relationship between agriculture and national economy, but there is little literature analyzing the macroeconomic effect of the agricultural development. From the income distribution effect and demand-pull effect, this paper analyzes the influence of agriculture on producers and consumers. The existing methods are mostly based on sensitivity coefficient and influence coefficient[5], and this paper uses the driving force coefficient to analyze the relationship between the agricultural development and national economy by constructing the input-output table and uses input-output analysis to measure the macroeconomic effect of agriculture[6]. The existing analysis is mainly based on the data prior to 2007, and this paper uses the Chinese input-output table released by National Bureau of Statistics in 2010 to measure, in order to make the conclusions more timely.

2 Model design

2.1 Input-output analysis Input-output analysis, developed by American economist Wassily W. Leontief in the 1930s, is an economic mathematical method based on the perspective of number system. It examines the interdependence between different sectors of a complex economic system, and it is widely applied to the analysis of industry linkage[7] and industry spread effect[8]. In this paper, based on research focus, the input-output table is simplified as follows:

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Table 1 Input-output analysis

	Product sector			Final product	Total output
Product sector	x_{11}	$\cdots$	x_{1n}	f_1	x_1
	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\vdots$
	x_{n1}	$\cdots$	x_{nn}	f_n	x_n
Initial input	w_1	$\cdots$	w_n		w
Total input	x_1	$\cdots$	x_n	f	

$x_{ij} \in X$ denotes that sector i is the intermediate factor matrix of sector j; $x_{ij} \in X$ and $f_j \in f$ are the total output column vector and the final product column vector of sector j, respectively; $w_i \in w$ is the initial input row vector of sector i. From the identical equation of total output, we can get Leontief model[9]:

$$x = (1 - A)^{-1} f$$

where A is the direct consumption coefficient.

We get the Leontief inverse matrix as follows:

$$L = (1 - A)^{-1} = I + A + A^2 + A^3 + \cdots = \sum_{i=0}^{+\infty} A^i \quad (1)$$

where i is an integer.

From the identical equation of total input, we get Ghosh model[10]:

$$x' = w(I - B)^{-1}$$

where x' is the total input row vector; w is the initial input row vector; B is the direct distribution coefficient.

We further get Ghosh inverse matrix as follows:

$$G = (1 - B)^{-1} = I + B + B^2 + B^3 + \cdots = \sum_{i=0}^{+\infty} B^i \quad (2)$$

2.2 Industry linkage analysis

2.2.1 The influence coefficient. Our concern is the influence of agriculture on national economy as a whole, so we use the influence coefficient to represent the backward pulling effect, and use driving force coefficient to represent the forward pushing effect. The degree of influence of national economy on agriculture is represented by reaction coefficient, and the specific form is as follows:

$$a_j = \frac{\sum_i l_{ij}}{\frac{1}{n}\sum_j \sum_i l_{ij}} \quad (i, j = 1, 2, 3, \cdots, n) \quad (3)$$

where α_j is the influence coefficient of sector j, indicating the role of end use change of one industry in boosting demand of various sectors in the national economy, and if this coefficient is greater than 1, the role of end use change of the sector in boosting demand of the national economy is greater than the average; l_{ij} is the full demand coefficient, also known as Leontief inverse matrix coefficient; denominator $\frac{1}{n}\sum_j \sum_i l_{ij}$ denominator is the average role of all sectors increasing the same end use in promoting the total output of national economy.

2.2.2 Sensitivity coefficient. Sensitivity coefficient is calculated based on the sum of row vectors of Leontief inverse matrix. Its economic meaning is the degree of demand sensitivity of total output in one sector when all sectors of national economy increase by one unit of end use. It also can be understood as the degree of dependence of a sector on national economy. Specific formula is as follows:

$$\beta_i = \frac{\sum_j l_{ij}}{\frac{1}{n}\sum_j \sum_i l_{ij}} \quad (i, j = 1, 2, 3, \cdots, n) \quad (4)$$

where β_i is the sensitivity coefficient of sector i, and if β_i is greater than 1, it indicates that the dependence of sector i on the overall development of national economy is higher than the industry average.

2.2.3 Driving force coefficient. Since the backward nature of demand-driven measurement methods does not match the forward characteristics of sensitivity coefficient, Ghosh (1958) develops the column input-output model to characterize the intrinsic linkage between initial input variation and total output change. In order to distinguish it from the concept of sensitivity coefficient, we call it driving force coefficient. The formula is as follows:

$$\phi_i = \frac{\sum_j g_{ij}}{\frac{1}{n}\sum_j \sum_i g_{ij}} \quad (i, j = 1, 2, 3, \cdots, n) \quad (5)$$

where ϕ_i is the driving force coefficient; g_{ij} is the full supply factor, also known as Ghosh inverse matrix coefficient; numerator $\sum_j g_{ij}$ signifies the role of sector i increasing one unit of initial input in promoting the national economy; denominator $\frac{1}{n}\sum_j \sum_i g_{ij}$ signifies the average role of all sectors increasing one unit of initial input in promoting the national economy; ϕ_i is the size of driving force of sector i relative to the average driving force of various sectors in national economy.

2.3 Economic effect analysis

2.3.1 Income distribution effect. Income distribution effect is mainly from four aspects: workers' remuneration; corporate operating surplus; net government taxes on production; depreciation of fixed assets. Worker's remuneration coefficient reflects the distribution of labor income share in GDP. When the workers' wage level does not change, workers' remuneration increase means an increase in employment, so it also reflects the influence of an industry on employment. Corporate operating surplus coefficient can reflect the return on capital of enterprises when the capital input remains unchanged. High net taxes on production mean high allocated shares of government in the industrial value added. Depreciation coefficient of fixed assets reflects the enterprises' compensation for fixed assets losses, and high depreciation coefficient of fixed assets reflects the high replacement rate of industrial technology and equipment. The above four aspects are similar to the input-output table structure, and the calculation is also similar. We only take workers' remuneration as an example to illustrate the calculation mode of income distribution effect. The direct workers' remuneration coefficient $\alpha_{vj} \in A_v$ is signified by formula (1):

$$a_{vj} = v_j / X_j (j = 1, 2, \cdots L, n) \quad (6)$$

where α_{vj} is the direct labor cost input for total output of sector j; $v_j \subset w_j$ and X_j are the workers' remuneration and total input in sector j.

The complete workers' remuneration coefficient $l_{vj} \in L_v$ can be expressed as:

$$L_v = A_v(I-A)^{-1} \quad (7)$$

where l_{vj} is the workers' full cost input for the production of final products in sector j; A_v is the row vector of direct workers' remuneration coefficient; A is the direct consumption coefficient; $(1-A)^{-1}$ represents Leontief inverse matrix.

2.3.2 Demand-pull effect. Direct consumer distribution coefficient reflects the share of some final products consumed in an industry in total output, and complete consumption distribution coefficient reflects the degree of consumption of the final products in an industry through the industry cycle. High consumption distribution coefficient reflects high demand-pull ability in the industry. Direct consumer distribution coefficient $b_{ci} \in B_c$ and complete consumption distribution coefficient $g_{ci} \in G_c$ are expressed by formula (8) and (9), respectively:

$$b_{ci} = c_i / X_i \quad (i = 1, 2, \cdots, n) \quad (8)$$

where $c_{i \text{ and}} X_i$ are the final product of sector i for consumption and total output, respectively.

$$G_c = (I-B)^{-1} B_c \quad (9)$$

where B_c is the column vector of direct consumer distribution coefficient; B is the direct distribution coefficient; $(I-B)^{-1}$ is Ghosh inverse matrix.

Based on the input-output structure, demand-pull effect is subdivided into pulling effect of rural residents, pulling effect of urban residents, pulling effect of government consumption, pulling effect of fixed capital formation, pulling effect of export, and pulling effect of import.

3 Empirical analysis

3.1 Data sources In this paper, we use the data in Chinese input-output tables in 2005 and 2010 released by National Bureau of Statistics. The data are from *China Statistical Yearbook* in 2008 and 2013. In 2005, there were 42 sectors, and in 2010, "scrap waste" was included in "handicrafts and other manufacturing", so there were 41 sectors. This change does not affect the analysis on the correlation between agriculture and the national economy as well as its macroeconomic effect.

3.2 Analysis of results

3.2.1 Correlation between agriculture and the national economy. We can see from Table 2 that the influence coefficient of Chinese agriculture is lower than average, and the influence coefficient in 2010 was slightly lower than in 2005, indicating that Chinese agriculture has a small backward pulling impact on the national economy, and this influence is still declining. By the sensitivity coefficient greater than 1, it can be found that Chinese agriculture's dependence on the national economy is higher than the average, and this dependence continues to increase over time. By comparison of driving force coefficient, we see that the forward pushing effect of Chinese agriculture on the national economy is lower than the average, but there is an upward trend. In summary, the forward pushing effect of Chinese agriculture on national economy is greater than the backward pulling effect of Chinese agriculture on national economy, and the influence is less than the dependence on national economy. The main reason is that China's economic construction is mainly based on the secondary industry, the agricultural science and technology and equipment input is lagging behind, and agricultural products are at the front end of the production chain.

3.2.2 Macroeconomic effect. From the measurement results of income distribution effects, the workers' remuneration coefficient of agriculture was higher than the average in 2010, indicating that the distribution of income is mainly in favor of laborers. The direct consumption coefficient is equivalent to more than three times of the average, indicating that this distribution is mainly in the agricultural industry. Compared with 2005, the proportion of workers' remuneration slightly increased, indicating that the contribution of the agricultural laborers to agriculture increases. In 2010, the net taxes on production occupied a small share in agricultural income distribution, much lower than the industry average, which is mainly reflected in the impact on other industries. Compared with 2005, the coefficient slightly decreased, indicating that the government has always adhered to tax preferential policies on agriculture. Whether it is direct consumption coefficient or complete consumption coefficient, the fixed assets depreciation coefficient of Chinese agricultural production was only half the industry average in 2010, suggesting that agricultural production equipments are slowly upgraded, and the degree of modernization is low, restricting modern agricultural productivity increase. Operating surplus coefficient reflects the enterprise's return on invested capital. From the direct consumption coefficient, the pure agricultural production enterprises have hardly any profitability, but from the complete consumption coefficient, enterprises have certain profit ability through the integration of agriculture and related industries, but this ability is still less than a third of the industry average. From the measurement results of demand-pull effect, the consumption of urban residents was the primary factor to drive agricultural demand in 2010, but compared with 2005, although the complete distribution coefficient was obviously lower than the industry average, the direct distribution coefficient was less than average, which indicates that urban residents occupy an important position in the agricultural demand, but it obviously slows down relative to the growth rate of other industry needs. Rural residents are the main group of agricultural spending, and both direct consumption coefficient and complete consumption coefficient show that rural residents' consumption in agriculture is far greater than the industry average. As one of three major consumption types, the governmental consumption plays a minimal role in the agricultural field. Fixed capital formation reflects the enterprises' purchase and retention of agricultural products, and the proportion of this part is increased, but it still far less than the industry average. Consumption abroad does not have a significant impact on Chinese agriculture, indicating that the international competitiveness of agriculture is weak, but agricultural export plays a more obvious leading

role than other industries, so the full distribution coefficient is significantly improved. The direct distribution coefficient of import effect is significantly greater than that of export effect, suggesting that the international competitiveness of Chinese agriculture is poor. The direct distribution coefficient of import effect in 2010 is greater than in 2005, which shows that Chinese people's demand for imported agricultural products grows, and China has the potential market space for the domestic agricultural development. However, the full distribution coefficient of import effect in two years was slightly lower than that of export effect, indicating that the indirect impact of imported agricultural imports on the national economy is less significant than the indirect impact of export effect on the national economy.

Table 2 Agricultural industry linkage indicators

Year	2010	2005
Influence coefficient	0.716 1	0.725 7
Sensitivity coefficient	1.781 8	1.748 8
Driving force coefficient	0.964 3	0.837 0

Table 3 Calculation results of income distribution effect

Year	2010				2005			
Classification	Direct consumption coefficient	The industry average	Complete consumption coefficient	The industry average	Direct consumption coefficient	The industry average	Complete consumption coefficient	The industry average
Workers' remuneration	0.5563	0.1768	0.7897	0.4430	0.5529	0.1428	0.7628	0.3555
Net taxes on production	0.0011	0.0486	0.0572	0.1576	0.0015	0.0445	0.0542	0.1396
Depreciation of fixed assets	0.0273	0.0546	0.0714	0.1421	0.0303	0.0598	0.0802	0.1566
Operating surplus	0.0000	0.0864	0.0818	0.2573	0.0000	0.1316	0.1029	0.3484

Table 4 Calculation results of demand-pull effect

Year	2010				2005			
Classification	Direct consumption coefficient	The industry average	Complete consumption coefficient	The industry average	Direct consumption coefficient	The industry average	Complete consumption coefficient	The industry average
Rural residents	0.0828	0.0260	0.2034	0.0681	0.1274	0.0352	0.2282	0.0887
Urban residents	0.0927	0.1214	0.4243	0.2826	0.1375	0.1143	0.3657	0.2838
Governmental consumption	0.0072	0.0890	0.0530	0.1556	0.0071	0.0886	0.0546	0.1572
Fixed capital formation	0.0483	0.0769	0.2116	0.4621	0.0358	0.0876	0.2427	0.4580
Export effect	0.0122	0.0836	0.2108	0.3216	0.0152	0.1237	0.2096	0.4403
Import effect	0.0592	0.1060	0.2009	0.3168	0.0437	0.1323	0.1699	0.4247

4 Conclusions and recommendations

4.1 Conclusions Based on input-output tables of China in 2005 and 2010, this paper gives a deep insight into the relationship between agriculture and national economy and its macroeconomic effects by the methods of input-output analysis, industrial correlation and macroeconomic effect analysis. The results show that the agricultural development is highly dependent on the national economy, but makes low contribution; agriculture contributes to promoting employment and improving the structure of national income distribution; despite the government's tax incentive, the agricultural equipments are updated slowly, and the corporate profits are at low level; agricultural export effect is far below the average industry level, but the import effect increases over the years, and final products are often used for domestic consumption.

4.2 Recommendations Based on actual agricultural situation, it is necessary to vigorously promote intensification, specialization and modernization of agriculture, use organizational and technological innovation to boost agricultural development, improve agricultural industry chain service system, continue to promote the deep processing of agricultural products, and improve the leading role of agriculture in upstream and downstream industry chain, to promote sound and fast economic development. Increasing the income of farmers and making agricultural enterprises obtain good returns is the original power to encourage farmers and enterprises to carry out equipment update, technical improvement and organizational innovation, so it needs the market forces to promote scientific agricultural operation and also needs the power of government to use tax relief and talent training tools to support agricultural development. Food security is an important part of national security. To ensure food security, it is necessary to focus on food quality and safety and pay close attention to the production source in order to promote national consumption, march into international market. It is also necessary to focus on sufficient quantity of food. Chinese people must rely on themselves to solve the problem of problem, so it is necessary to protect the basic farmland, strengthen technological innovation to improve yield, and introduce advanced technology and superior varieties from abroad.

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