Empirical Analysis of the Impact of Adjustment of Agricultural Structure on Agricultural Economic Growth in Xinjiang

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Abstract We conduct empirical analysis of the contribution of various sectors of agriculture in Xinjiang to agricultural economic growth, and the impact of adjustment of these sectors on agricultural economic growth. The results show that the growth of farming has the greatest force to drive the growth of total agricultural output in Xinjiang, followed by animal husbandry; the rate of contribution of these two production sectors, farming and animal husbandry, not only shows high-frequency fluctuation, but also shows reverse fluctuation; the effect arising from adjustment of farming is gradually spreading to animal husbandry, forestry and fishery one by one, but the spreading rate is low. Finally the countermeasures and proposals are put forward to further adjust agricultural structure and promote agricultural economic growth of Xinjiang under the Twelfth Five-Year Plan as follows: adjust the industrial structure steadily, address the industry convergence and broaden the income-increase channels for the farmers; strengthen the input to adjustment of agricultural structure; stick to the combination of internal adjustment and external adjustment of agricultural industry.

Key words Xinjiang, Agriculture, Industrial restructuring, Economic growth, China

Adjustment of industrial structure, in essence, is the reallocation process of industrial resources, to attain the goal of fully utilizing resources and achieving economic growth through redistribution of resources[1]. The industrial structure is to play role dependent on the overall function, while the extent of exertion of overall function is often determined by the worst factor, which is called "law of limiting factors", namely the famous "wooden barrel law", so the fundamental path to industrial restructuring lies in coordination[2]. This also applies to agriculture, and the adjustment of agricultural structure will inevitably have great impact on agricultural economic growth[3-5].

We conduct analysis on the relationship between adjustment of agricultural structure and agricultural economic growth in Xinjiang. First, we analyse the impact of adjustment of agricultural sectors on total output value of agriculture, then analyse the relationship between adjustment of agricultural sectors and farmers' income growth, and finally based on the two levels, evaluate the effect of structural adjustment on agricultural economic growth. As for how to achieve economic growth, it includes not less than two aspects: first, to research what factors having impact on economic growth, namely the problem of contribution rate[6]; second, to further research how much the impact of this factor on economic growth, namely the elasticity problem[7].

1 Data source and research method

1.1 Data source The research data are from *Xinjiang Statistical Yearbook* in the period 1987 -2010.

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1.2 Research method

1.2.1 The calculation method of contribution of the agricultural structure. The rate of contribution of agricultural sectors to growth rate of total agricultural output RC_i can be written as follows:

$$RC_i = \frac{X_i}{Y} \cdot \frac{\Delta X_i / X_i}{\Delta Y / Y} \quad (1)$$

where Y is the total agricultural output; X_i ($i = 1,2,3,4$) is the output of sector i. The first part of the right expression (1) is the structural proportion of sector i. The second part is the ratio of growth rate of output of sector i to growth rate of total output, namely the relative growth rate of sector i. If the relative growth rate is bigger than 1, it indicates that sector i accelerates the growth of total agricultural output; if the relative growth rate is smaller than 1, it indicates that industry i decelerates the growth of total agricultural output. The rate of contribution of all sectors to growth rate of total agricultural output can be abbreviated as follows:

$$RC_i = \delta_i \times RR_i \quad (2)$$

where δ_i and RR_i are the structural proportion of sector i and relative growth rate.

The variation of contribution rate of sectors to total output can be written as follows:

$$\Delta RC_i = RR_i \cdot \Delta\delta_i + \delta_i \cdot \Delta RR_i \quad (3)$$

$$\Delta RC_i = \Delta RC_\delta \cdot \Delta RC_{RR} \quad (4)$$

where expression (4) indicates that the change of contribution rate can be divided into two parts: one is ΔRC_δ arising from structural changes in agriculture; the other is arising from changes in relative growth rate.

1.2.2 Establishment of sector elasticity analysis model. The effect of changes in industrial structure is the role of changes in industrial structure in influencing economic growth. We can de-

termine the effect of changes in industrial structure using the method of calculating elasticity coefficient. The elasticity coefficient of industry is the percentage of GDP increased when the added value of one industry increases by 1%. The elasticity coefficient of agriculture, forestry, animal husbandry and fishery is the percentage of total output value of agriculture when the output value of one sector increases or decreases by 1%.

The production function determined by the agricultural production sectors, coupled with technical and institutional factors is as follows:

$$Y = f(X_1, X_2, X_3, X_4, A) \quad (5)$$

where Y is total agricultural output; $X_i (i = 1,2,3,4)$ signifies the output of sector i; A is technical and institutional factors.

We work out derivative of time t of expression (5), to get the following expression:

$$Y' = \sum \partial Y/\partial X_i \times X'_i + \partial Y/\partial A \times A' \quad (6)$$

where Y', X'_i and A' are the derivatives of Y, X_i and A to time t. And we transform the derivation expression, to get the following expression:

$$\frac{Y'}{Y} = \sum_{i=1}^{4} \frac{\partial Y}{\partial X_i}\frac{X_i}{Y}\frac{X'_i}{X_i} + \frac{\partial Y}{\partial A}\frac{A}{Y}\frac{A'}{A} \quad (7)$$

where the left is the growth rate of total output, marked as y; $\sum_{i=1}^{4} \frac{\partial Y}{\partial X_i}\frac{X_i}{Y}$ is the output elasticity of sector i, marked as a_i; $\frac{X'_i}{X_i}$ is the output growth rate of sector i, marked as x_i; the rearmost term on the right is the contribution of technical and institutional factors to growth of total agricultural output, marked as a_0. Therefore, we can use the following linear regression model to analyse the contribution of agricultural sectors to agricultural economic growth:

$$y = a_0 + \sum a_i x_i + \varepsilon \quad (8)$$

where ε is random disturbance term.

2 Results and analysis

2.1 Contribution of adjustment of agricultural sectors to agricultural economic growth One of sources of agricultural economic growth is progress in agricultural science and technology, and the progress in agricultural science and technology is specifically reflected in improvement of production capacity of agricultural production sectors. Different rates of technological progress promote the constant changes in agricultural structure, while the changes in agricultural structure are bound to cause fluctuations in agricultural economy.

Since 1985, the annual growth rate of agricultural added value and the rate of contribution of agricultural sectors to the growth rate of agricultural added value, are mainly from farming, followed by animal husbandry. The contribution rate (RC_i) of Xinjiang's agricultural sectors in the period 1986 – 2009 can be seen in Table 1. In the period 1986 – 2009, the average growth rate of added value of agriculture, forestry, animal husbandry and fishery is 7.32%. The average contribution rate of farming is 74.77%; the average contribution rate of forestry is 1.85%; the average contribution rate of animal husbandry is 22.897%; the average contribution rate of fishery is 1.357%.

Table 1 The contribution rate (RC_i) of Xinjiang's agricultural sectors in the period 1986 – 2009 %

Sector	Average value	Maximum	Minimum	Coefficient of variation
Farming RC_1	74.77	104.21	54.06	3.60
Forestry RC_2	1.85	8.85	−3.40	32.74
Animal husbandry RC_3	22.89	43.50	−5.40	10.12
Fishery RC_4	1.35	4.46	0.15	17.59

As can be seen from Table 1, the rate of contribution of agriculture, forestry, animal husbandry and fishery to total growth rate of added value is unstable, and the fluctuation coefficients are all large, for example, the greatest contribution rate of farming is 104.55%, and the smallest contribution rate of farming is 54.06%; the greatest contribution rate of animal husbandry is 43.5%, and the smallest contribution rate of animal husbandry is −5.4%. This situation reflects the instability and risk of agricultural production. Under the joint action of natural risks and market risks, the vulnerability of agriculture in Xinjiang looms large. From the analysis of variation trend in the contribution rate of agricultural sectors, we can find that the contribution rate of farming and animal husbandry and fishery not only shows high-frequency fluctuation, but also shows reverse fluctuation, that is, when the contribution rate of agriculture rises, the contribution rate of animal husbandry and fishery declines; when the contribution rate of agriculture declines, the contribution rate of animal husbandry and fishery rises, and shows cyclical changes, roughly 3 to 4 years amounting to a cycle (Fig. 1).

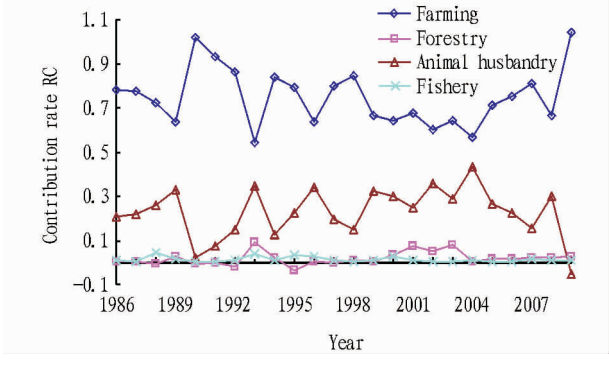

Fig. 1 Change in contribution rate of Xinjiang's agricultural sectors in the period 1986 – 2009

From the formula of variation of contribution rate, we can find that the contribution rate of all sectors is primarily influenced by the structural proportion of the industry and the relative growth rate of all sectors. Thus we can calculate the impact of structural change in agriculture, forestry, animal husbandry and fishery on contribution rate, and explain the reason of fluctuations in contribution rate of all sectors. Given that since 2001, China has officially implemented Development of the West Regions in Xinjiang, therefore, the period 2002 – 2009 is regarded as a stage of development; at the same time, the period 1992 – 2001 is in the period of the Ninth Five-Year Plan and Eleventh Five-Year Plan, so we take these two periods as one stage; the period 1987 – 1991 is also regarded as a stage of development. Here we only list the stage average value from decomposition of variation in contribution rate (Table 2).

Table 2 Stage average value from decomposition of variation in contribution rate

Stage	Farming			Forestry			Animal husbandry			Fishery		
	ΔRC	ΔRC_δ	ΔRC_{RR}	ΔRC	ΔRC_δ	ΔRC_{RR}	ΔRC	ΔRC_δ	ΔRC_{RR}	ΔRC	ΔRC_δ	ΔRC_{RR}
1987 – 1991	2.98	0.76	2.36	−0.08	0.03	0.01	−2.70	0.19	−2.21	−0.17	0.28	−0.28
1992 – 2001	−2.54	−0.09	−2.38	0.72	0.21	0.73	1.75	0.39	1.55	0.04	0.14	−0.04
2002 – 2009	4.56	−0.04	4.71	−0.57	0.15	−0.66	−3.80	0.68	−4.04	0.03	0.01	0.03

Table 2 shows that in the period 1987 – 1991, the impact of structural proportion variation in farming, forestry, animal husbandry, and fishery on contribution rate is positive; the impact of variation in relative growth rate of farming and forestry on contribution rate is positive. In the period 1992 – 2001, the impact of structural proportion variation in farming on contribution rate is negative, and the impact of structural proportion variation in other sectors is positive; as for the impact of variation in relative growth rate, the farming and fishery are both negative. In the period 2002 – 2009, only the impact of structural proportion variation in farming on contribution rate is negative; apart from animal husbandry, the impact of variation in relative growth rate of other sectors on contribution rate is positive. The above analysis shows that the structural effect arising from adjustment of farming is gradually spreading to animal husbandry, forestry and fishery, but it spreads slowly. It can be also found from Table 2 that the variation trend of the impact of variation in relative growth rate of farming, and the impact of variation in relative growth rate of animal husbandry is opposite, which also explains why the contribution rate of farming and animal husbandry shows reverse fluctuation.

2.2 Elasticity analysis of agricultural sectors According to formula (8), we adopt agricultural GDP of Xinjiang in the period 1985 – 2009 as the sample value of total output, and the sample observational value of farming, forestry, animal husbandry and fishery, to calculate the total output value of agriculture and growth rate of output value of all sectors using the statistical software for each sample observation sequence. The regression results can be shown in Table 3.

Table 3 Regression results of elasticity analysis model of sectors

y	Constant	x_1	x_2	x_3	x_4	$\overline{R}^2$	*DW* statistic	*F* statistic	*P* value
Model 1	0.000 2	0.761 1	0.021 9	0.208 6	0.000 3	0.999	1.85	5 506.05	0.000
	(0.257)	(139.5)***	(6.6)***	(32.4)***	(0.160)				
Model 2	0.000 2	0.761 1	0.021 7	0.208 9		0.999	1.88	7 717.37	0.000
	(0.293)	(143.6)***	(7.2)***	(35.0)***					

Note: What in brackets is *t* statistic and *** indicates significant at level of 1%.

In Table 3, y is the growth rate of total agricultural output value; x_1, x_2, x_3, x_4 are growth rate of output value of farming, forestry, animal husbandry, and fishery, respectively. *F*-test shows that Model 1 and Model 2 are statistically significant, and the goodness of fit adjusted of two models has reached 99.9%. At the same time, *DW* statistical test also shows that there is no significant residual first-order autocorrelation in two models, but in Model 1, *t*-test of x_4 shows that it is not significant statistically. Thus, compared to Model 1 and Model 2, we can know that Model 2 is more effective.

From Model 1, we can find that the impact of variation in growth rate of output value of fishery on variation in growth rate of total output value of agriculture is small. According to Model 2, the output elasticity of farming, forestry and animal husbandry is approximately 0.761 1, 0.021 7, and 0.208 9, respectively, that is, when the output of farming, forestry, and animal husbandry increases by 1 percentage point, it will cause the total agricultural output of corresponding sectors to grow by 0.761 1, 0.021 7, and 0.208 9 percentage point, respectively. Since the linear summation of output value of farming, forestry, animal husbandry and other sectors is approximately equal to agricultural GDP, the proportion of growth of total agricultural output driven by the growth of farming, forestry, animal husbandry and other sectors is about 76.11%, 2.17%, and 20.89%, respectively. Thus, the growth of farming has the greatest force in driving the growth of total agricultural output, followed by animal husbandry. This analysis result is in line with the actual situation of agricultural natural resources in Xinjiang. Therefore, giving top priority to the development of farming and animal husbandry for promoting agricultural economic development in Xinjiang, is a scientific choice.

3 Conclusion and countermeasures

3.1 Conclusion The results show that the growth of farming has the greatest force in driving the growth of total agricultural output, followed by animal husbandry. Therefore, giving top priority to the development of farming and animal husbandry for promoting agricultural economic development in Xinjiang, is a scientific choice. On the basis of analysing the elasticity of output value of agricultural sectors to total output value of agriculture, we further research the contribution of structural adjustment in output value of all sectors to variation in total output value of agriculture. From the analysis of variation trend of contribution rate of agricultural sectors, we can find that the rate of contribution of these two production sectors, farming and animal husbandry, not only shows high-frequency fluctuation, but also shows reverse fluctuation; the effect arising from adjustment of farming is gradually spreading to animal husbandry, forestry and fishery one by one, but the spreading rate is low.

Although the process of adjustment of agricultural structure is influenced and restricted by a variety of factors, adapting to

economic development is the inevitable result, and the law of adjustment of agricultural structure takes shape in contradiction between adaption and maladaptation. But the adjustment must be based on achieving agricultural economic growth as the most fundamental goal, because there is a close relationship between agricultural economic growth and agricultural structure, and adjustment of agricultural structure is bound to be beneficial to the growth of the agricultural economy.

3.2 Countermeasures When conducting adjustment of agricultural structure in Xinjiang, we should take the Twelfth Five-Year Plan of Xinjiang Autonomous Region as guidance, the construction of new socialist countryside as center. Based on the actual situation of Xinjiang, the following countermeasures and proposals are put forward.

3.2.1 Adjust the industrial structure steadily, address the industry convergence and broaden the income-increase channels for the farmers. The income from farming in Xinjiang is still one of the major sources of agricultural revenue in Xinjiang. For the adjustment of farming, we should take farming as the leading industry based on the actual situation of all regions, and vigorously develop the cash crops in line with the situation of local natural resources. For the fruit industry, we should lay stress on the adjustment of structure of the fruit industry in Xinjiang, because the development of the fruit industry is of great significance to promoting the development of agriculture in Xinjiang, and increasing farmers' income. For the adjustment of animal husbandry and fishery, based on existing development status, we should introduce and improve high-quality livestock varieties, and enhance the overall grade of livestock products in Xinjiang.

3.2.2 Strengthen the input to adjustment of agricultural structure. As the development level of the agricultural economy is low, and the economic capacity is weak, so in the process of adjustment of agricultural structure in Xinjiang, we must increase the input to adjustment of agricultural structure. These inputs mainly include preferential policies, capital input, and technology input. At the same time, we must strive to improve the quality of the rural population, increase investment in rural education, and promote rural human capital. In the final analysis, we should strive to improve the quality of the rural population, in order to propel the strategic adjustment of agricultural structure and improve the quality of agricultural products and market competitiveness.

3.2.3 Stick to the combination of internal adjustment and external adjustment of agricultural industry. With the continuous adjustment of agricultural structure and constant extension of industrial chain accompanied by the adjustment, the external role of agriculture becomes more and more obvious. This role will restrict or promote the adjustment of agricultural structure, therefore, the development of agriculture is far from enough, and we must coordinate the development of entire economy in society.

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3 Conclusions

We normalize different explicit dominance indices of production and development of crops (Table 5). By observing the data distribution characteristics, we classify it into three levels: if the index value is bigger than 0.6, it indicates that this crop is fit to expand the scale; if the index value is in 0.3-0.6, it indicates that this crop is relatively fit to expand the scale; if the index value is smaller than 0.3, it indicates that this crop is not fit to expand the scale.

The results show that the normalized explicit dominance of rice, sugarcane, mulberry, Sanhua plum and Jiuxian peach in Wengyuan County is 0.23, 0.94, 0.33, 0.22 and 0.46, respectively; in Wengyuan County, the sugarcane is fit to expand the scale, the mulberry and Jiuxian peach are relatively fit to expand the scale, and the rice and Sanhua plum are not fit to expand the scale.

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