The coordination between urbanization and agricultural modernization in China

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Abstract: In this paper we build urbanization system and agricultural modernization system and calculate their synthetical scores by using AHP model and principle component analysis with data from 1991-2010. Based on the system scores, we build measure scaling function to calculate coordination degree between urbanization system and agricultural modernization system to analyze and quantize the coordination between urbanization and agricultural modernization in China in recent twenty years. The facts show that at the middle and after period of urbanization, putting the income of urban development into agricultural and rural construction would bring better effect.

Key words: coordination degree; urbanization; agricultural modernization

JEL classification: R11

1. Introduction

Rural areas and urban areas are two circumstances which manifest two types of production and life styles. Urbanization which promotes the quality of urban life and agricultural modernization which promotes the quality of rural production and life are the process to social modernization. China's urbanization rate was 51.27%, exceeding 50% for the first time in 2011. This historic turning point in China's social structure meant that population in urban areas exceeded population in rural areas and China becomes an urbanization country in demographic significance. A large amount of literature studied the relationship between urbanization and agricultural modernization through theoretical and historical analysis and concluded that developments of urbanization and agricultural modernization in China's social and economic process demonstrate certain degrees of priority order and the dual system of rural and urban isolation and development mode with "urban preference" lead to uncoordinated urban-rural relations in China's modernization process. Current

researches are lack of empirical analysis on the coordination of relationship between urbanization and agricultural modernization.

Chenery and Syrquin (1975) proposed the development patterns of urbanization and agricultural modernization, that is, the urbanization would promote an improvement of industrial structure, which would bring an increase of income per capita (GDP per capita) and an accelerated development of cities and towns, and finally induce the transfer of rural surplus labor as well as the development of agricultural modernization. Gu Shengzu (1991) believed that the urbanization is conducive to dimensions of the agriculture. Besides, the urbanization would also provide material and technological foundation for agricultural modernization. However, the selection of the way of agricultural modernization and the land system might restrict the urbanization in the process of urbanization and agricultural modernization. Han Changfu (2002) held that the urbanization of rural area, the agricultural modernization, and the realization of well-off of rural residents always keep in step. As a result, the urbanization and agricultural modernization shall be given overall consideration, that is, the problems of urbanization and agricultural modernization should be solved simultaneously. Zheng Xin (2005) considered that, on the one hand, the urbanization and agricultural modernization rely on each other and condition each other. On the other hand, there is contradiction resulting from their competition for resources between the urbanization and agricultural modernization. In order to boost the steady growth of national economy, the only way is to deal with the relationship of urbanization and agricultural modernization and make them development coordinately. Yin Chengjie (2012) thought that the urbanization have a greatly positive impact on agricultural modernization. He emphasized that the urbanization which favors the releasing of demand in agriculture and rural area and the realization of equalization of urban-rural development is an important engine of agricultural modernization.

Taken together, the interaction between urbanization and agricultural modernization has been discussed from the perspectives of the transfer of rural surplus labors, the change of agricultural structure, etc. And the main conclusion is

that the urbanization and agricultural modernization provide foundational conditions for each other, but restrict each other on the allocation of resources.

In order to quantify the interaction between urbanization and agricultural modernization, this paper builds urbanization system and agricultural modernization system and calculates their composite scores by using data from 1991-2010. Based on the system scores, it builds measure scaling function to calculate coordination degree between urbanization system and agricultural modernization system to analyze and quantize the coordination between urbanization and agricultural modernization in China in recent twenty years.

2. System building method of urbanization and agricultural modernization

A complete system is composed of evaluation indicators from different layers which selected by strict principles. By measuring the weight of different layers and then calculating every layer's score based on actual data, we get the weighted score of the system.

Principles of system building

The development of urbanization and agricultural modernization can be affected by many factors from different aspects and layers. In order to quantify the interaction of different factors, we build urbanization system and agricultural modernization system according to several principles. Firstly, scientific principle requires scientific methods and processes to choose evaluation indicators by surveying, discussing and testing. Secondly, systematic principle requires that every system is an organic whole and the indicators of every layer are complete and relatively independent. Thirdly, hierarchical principle requires that selected indicators can reflect the main features and situation of system from different layer and aspect. Fourthly, operable principle requires that the data sources need to be really effective, available and low-redundant. Finally, comparable principle requires consistency of data's statistical caliber and calculating methods.

Calculating steps

We use AHP (Analytical Hierarchy Process) model to determine the weight of every layer and principal component analysis to calculate the score of every layer.

There are four steps to determine the weight of every layer. First, we build analytical hierarchy model and determine criteria layer and sub-criteria layer. Then we judge the materiality between sub-criteria layers and construct judgment matrix. Table 1 illustrates the concrete meaning of each scale.

Table 1 The scale and meaning of judgment matrix

scale	meaning （*A and B are evaluation indicators of the system from the same layer.*）
1	A and B are equally important.
3	A is slightly more important than B.
5	A is obviously more important than B.
7	A is intensively more important than B.
9	A is extremely more important than B.
2,4,6,8	2,4,6,8 indicate the mid-value of 1-3, 3-5, 5-7, 7-9 separately.
reciprocal	If C is the comparative judgment result of A to B, then the result of B to A is 1/C.

The third step is to do consistency check of each judgment matrix which needs to calculate the largest eigenvalue (λ max) and consistency index ($CI = \frac{\lambda \max - n}{n-1}$). Then calculate the consistency ration (CR= CI/RI). Table 2 shows the random index (RI) of different orders. If CR＜0.1 we consider the matrix has content consistency and the weight distribution is reasonable. If not, we need to adjust the value of evaluation matrix until it passes the consistency check.

Table 2 The random index of average consistency

order	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

The fourth step is to calculate the relative weight of each sub-criteria layer if the matrix passes the consistency check by unitary processing the eigenvector of the matrix.

In system analysis, we choose multi-aspect and multilayered indicators to synthetically illustrate all sorts of affections of the system. It is inevitable that those indicators have some correlations and make overlaps in the statistic data. In order to solve the correlations and complexity of multiple indicators, we use principal component analysis to extract principal components. It converts multiple indicators to several factors as far as possible to keep all the original information and extracts the main factors which can reflect the indicators' information. Thus we apply statistic software SPSS 18.0 to analyze and calculate. The main steps are: (1) Test the indicators of every sub-criteria layer with KMO test and Bartlett's test. Only when the KMO coefficient is greater than 0.5 and the p value of Bartlett's test is less than 0.05 we can perform factor analysis. (2) Standardize the original data by Z-score method to eliminate dimension affects. (3) Build correlation coefficient matrix of indicators and calculate eigenvalue and eigenvector of the matrix. (4) Select the factors whose eigenvalue is greater than 1 or the total cumulative variance is greater than 85%. (5) Multiply the matrix of factors' eigenvalue and score, calculate the total score of every layer.

Multiply the matrix of weight and total score of every layer, we can get the synthetically weighted score of the system.

3. The evaluation results of urbanization system and agricultural modernization system

Urbanization system

Urbanization is a process with demographic shifting from country to cities and non-agricultural industries clustered in cities. As the number of cities has increased and the scale of cities is expanding, the development of urbanization has gradually been transformed into inner quality instead of external quantity. So when building the urbanization system, we consider the traditional urban economic level as well as

the living facilities, qualities and environment in cities. The specific indicators are in table 3.

Table 3 The evaluation indicators of urbanization system

Criteria layer	Sub-criteria layer	Evaluation layer	Sub-criteria layer	Evaluation layer
Development level of urbanization (DLU)	Urban economic level (UEL)	Proportion of non-agricultural output value	Quality of urban life (QUL)	Health workers per thousand people
		Proportion of non-agricultural employment		Beds in medical and health institutions per thousand people
		Urbanization rate		Enrollment rate of high school
		Proportion of Urban fixed asset investment in total fixed assets investment		Quantity of public libraries
		Per capita disposable income of urban households		Pension coverage Rate of urban workers
		Per capita consumption expenditure of urban households		Proportion of criminal cases
		Engel's coefficient of urban households	Urban living environment (ULE)	Urban population density
		Per capita savings deposits		Per capita public green area
		Ratio of urban-rural income		Green coverage rate of built-up area
	Urban living facilities (ULF)	Per capita road area		Per capita housing area of urban residents
		Buses ownership per ten thousand people		Rate of urban sewage disposal
		Popularization rate of water		Environmental pollution and damage frequency
		Popularization rate of gas		
		Coverage rate of TV		

By comparing the importance between the sub-criteria layer, we get the judgment matrix in table 4. The judgment matrix could pass the consistency check. We calculate the weight of every sub-criteria layer and get the results in table 5. Using SPSS18.0 and the data of above indicators, we calculate the synthetical score of the system in figure 1. Data sources include China Statistical Yearbook and China City Statistical Yearbook (1992-2011).

Table 4 The judgment matrix of the sub-criteria layer in urbanization system

	UEL	QUL	ULE	ULF
UEL	1	2	3	3
QUL	1/2	1	3	2
ULE	1/3	1/2	1	1
ULF	1/3	1/2	1	1

Table 5 The weight of the sub-criteria layer in urbanization system

sub-criteria layer	weight
UEL	0.4547
QUL	0.2631
ULE	0.1411
ULF	0.1411

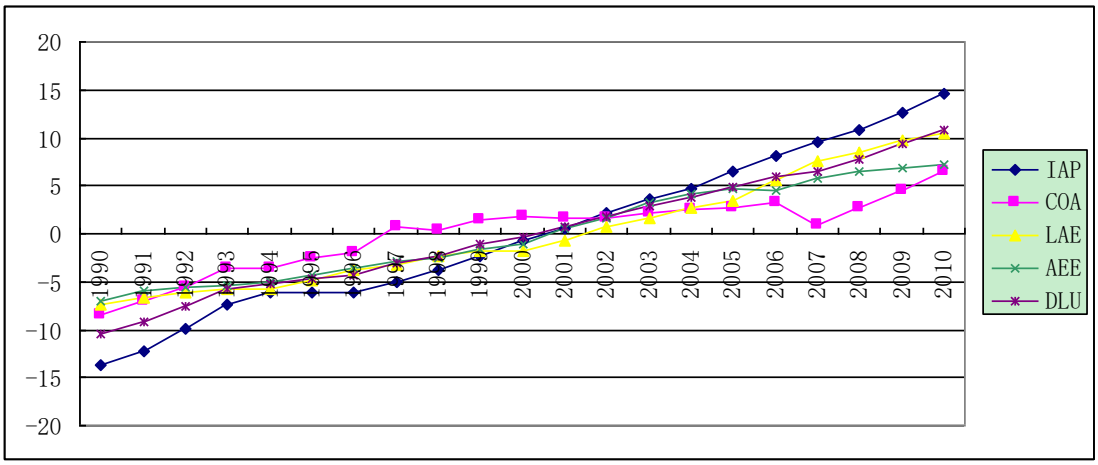

Figure 1 The synthetical score of urbanization system

Agricultural modernization system

The development of agricultural modernization is the process of increasing traditional agricultural productivity been with the improving agricultural production means, advancing agricultural science and technology content and optimizing agricultural operation and management way. So as to build the agricultural modernization system, we synthetically consider the aspects of agricultural input and

output level, agriculture and rural economic development level and agroecological environment change. The specific indicators are in table 6.

Table 6 The evaluation indicators of agricultural modernization system

Criteria layer	Sub-criteria layer	Evaluation layer	Sub-criteria layer	Evaluation layer
Development level of agricultural modernization (DLAM)	Input of agricultural production (IAP)	Total power per unit arable land	Comprehensive output of agriculture (COA)	Grain production per worker
		Dosage of chemical fertilizer per arable land		Cotton production per worker
		Electricity consumption per arable land		Oil production per worker
		Effective irrigation rate		Aquatic production per worker
		Arable land per worker		Meat production per worker
		Proportion of agricultural spending accounts for fiscal expenditure		Agricultural labor productivity
		Employment in primary industry		Land productivity
	Level of agricultural economy (LAE)	Proportion of added value in primary industry	Agricultural ecological environment (AEE)	Per capita arable land
		Proportion of employment in primary industry		Agricultural hazard rate
		Per capita net income of rural households		Forest coverage rate
		Per capita consumption expenditure of rural residents		
		Engel's coefficient of rural households		

By comparing the importance between the sub-criteria layer, we get the judgment matrix in table 7. The judgment matrix could pass the consistency check. We calculate the weight of every sub-criteria layer and get the results in table 8. Using SPSS18.0 and the data of above indicators, we calculate the synthetical score of the system in figure 2. Data sources include China Agricultural Yearbook, and China Rural Statistical Yearbook (1992-2011).

Table 7 The judgment matrix of the sub-criteria layer in agricultural modernization system

	IAP	COA	LAE	AEE
IAP	1	2	2	3

COA	1/2	1	1	2
LAE	1/2	1	1	2
AEE	1/3	1/2	1/2	1

Table 8 The weight of the sub-criteria layer in agricultural modernization system

sub-criteria layer	weight
IAP	0.4231
COA	0.2272
LAE	0.2272
AEE	0.1225

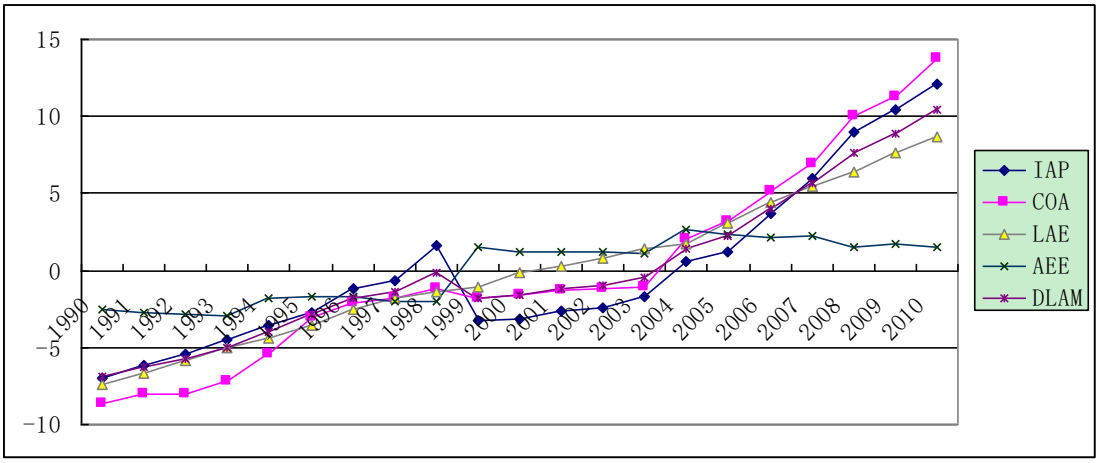

Figure 2 The synthetical score of agricultural modernization system

4. The coordination between urbanization and agricultural modernization

There are interaction effects between urbanization system and agricultural modernization system. Refer to the coordinated development theory and model (Wang Weiguo, 2000), we consider that the coordination degree is the extent of real development level to coordinated development level.

Calculating steps

We establish a scaling function ($C \in [0,1]$) of coordination coefficient to measure the extent of the coordinated development among subsystems, and the specific formula is:

$$C(\mathrm{a/u}) = \exp\left[-\frac{2\left|X_i - X_i'\right|}{S}\right]$$

$C(a/u)$ represents coordination coefficient that system a imposed on system u, and X_i' is an observed data of the actual development about system a, which obtained through the establishment of comprehensive evaluation index system of subsystems. X_i' is a development level of system a required by system u during the coordinated development of system a and u, which obtain coordination data through the establishment of regression equation fitting between these two systems. S represents the standard deviation obtained from the observed data of the actual development about system a. Coordination coefficient between the two systems is calculated as:

$$C(a,u) = \frac{\min(c(a/u), c(u/a))}{\max(c(a/u), c(u/a))}$$

Coordination coefficient C indicates its degree of coordination, which can specifically be divided into six intervals, C∈(0,0.2] means extreme disorder, C∈(0.2,0.4] is serious imbalance, C∈(0.4,0.6] is on the verge of disorders, C∈(0.6,0.75] for primary coordination, C∈(0.75,0.9] is good coordination, C∈(0.9,1] is highly coordinated.

Calculating results

We can calculate the system coordination of agricultural modernization(A) and urbanization System (U) by using the above steps and the synthetical scores in section 3. The specific results are shown in figure 3.

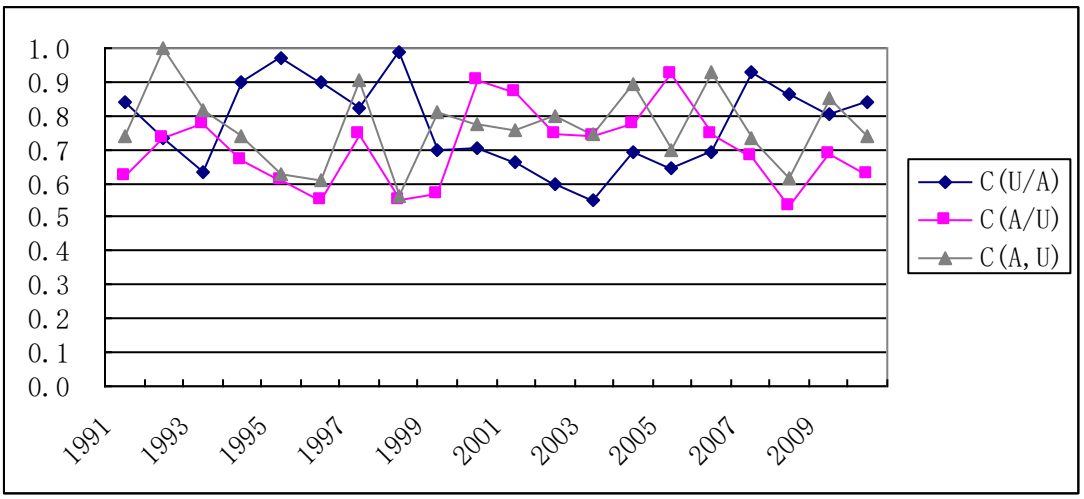

Figure3 The Coordination coefficient trends about systems of agricultural modernization and urbanization

1991-2010, the average value of coordination level（C(A/U)）that agricultural modernization imposed on the urbanization is 0.7031, which just reached the primary level of coordination, and its variation coefficient is 0.1639. The average value of coordination level（C(U/A)）that urbanization imposed on agricultural modernization system is 0.7731, which achieved a good level of coordination, and the variation coefficient is 0.1668, which indicates a slightly larger fluctuation than that of C(A/U). The average value of coordination level about agricultural modernization systems and urbanization systems C(A,U) is 0.7679, which is between the average value of C(A/U) and C (U/A), and it has a minimal volatility of 0.1479. Among them, many pseudo-high coordination of low level（C(A,U) is greater than the maximal one between C(A /U) and C(U/A)）exist in the coordination coefficient（C(A,U)）of agricultural modernization systems and urbanization System，and this situation emerged in 1992,1993,1997,1999,2002-2004, 2006 and 2009, which accounting for 45% among all of the C(A,U). Except for these pseudo-high coordination value, C(A,U) just has an average of 0.6920, which is less than the average value of total system coordination coefficient 0.7679. Even though it just reached the primary level of coordination, the coefficient of variation is only 0.107, which indicates a less overall fluctuation if we remove the pseudo-high coordination value from the system coordination value.

5. Conclusion

Overall, this paper selects four dimensions of 26 indicators to build an urbanization system, and selected four dimensions of 22 indicators to build an agricultural modernization system, using analytic hierarchy process and principal component analysis method to calculate the comprehensive score of the two systems. On the bases of the comprehensive score, it established the coordination degree scaling function to estimate the coordinated development of the two systems, and the results show that the coordinated coefficient between these two systems decreased at first and then increased. During the period of 1994 to 1999, compared with the coordinated level of agricultural modernization, the coordinated level of urbanization was better, and that means during this period, there was a large deviation between the development of agricultural modernization and the development which was coordinated with the urbanization development, the development of agricultural modernization was lagging behind; during the period of 2000 to 2006, the level of urbanization was deviated from the level which was coordinated with the development of agricultural modernization, the development of urbanization was lagging behind; during the period of 2007 to 2010, deviations between the level of agricultural modernization and the level which was coordinated with the urbanization became larger, and the impetus and the supports to the development of agricultural modernization was insufficient.

In the process of social and economic development in China, the development of urbanization has a greater effect on promoting the agricultural modernization than the counteractive effect, the developmental level of the agricultural modernization is lower and it lagged behind of the level of the urbanization. The facts show that at the middle and after period of urbanization, it can’t only rely on the accumulation of agricultural and rural resources, but on the contrary, putting the income of urban development into agricultural and rural construction would bring better effect.

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