Canonical Correlation Analysis on Impacts of Agricultural Modernization on Urbanization

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Keywords: agricultural modernization; urbanization; canonical correlation analysis; Wuhan City

Abstract: To study the impacts of agricultural input, agricultural output, rural social development and agricultural sustainable development on urbanization, e.g. population urbanization, economic urbanization, social urbanization and land urbanization, this paper selected statistics from 1995 to 2012, employed canonical correlation analysis method, diagnosed the correlations of impact factors between agricultural modernization and urbanization and made a test of results. The results showed that agricultural input, rural social development and agricultural sustainable development have played a significant role in urbanization, while agricultural output have few impacts on urbanization; population urbanization level and economic urbanization level could be advanced by the improvement of agricultural mechanization input and rural social development level; and social urbanization level will be improved with the rising of agricultural materials input and agricultural sustainable development level; besides, the improvement of agricultural materials input will also have a promotion on land urbanization.

1. Introduction

In the report of the Eighteenth National Congress of the CPC, the Central Committee of the Communist Party of China put forward "Adhering to the road of new industrialization, informatization, urbanization and agricultural modernization with Chinese characteristics"[1]. Take agricultural modernization for example, the development of urbanization process has played an important role in advancing development of agricultural modernization, meanwhile the advancing development of agricultural industrialization has also promoted the upgrading of urbanization level. The two are complementary to each other and develop harmoniously[2].However, there are also many difficult problems to be solved in the relationship between urbanization and agricultural modernization, such as the obstacle to mobility of labor by the dual structure of urban and rural area[3],the continuous reduction of cultivated land by rapid urbanization [4], unreasonable distribution of land income and resources[5].Objectively grasping the relationship between urbanization and agricultural modernization, quantitatively analyzing the key factors and modes of action which drive their development process, and understanding the effective way to adjust the development of urbanization through agricultural modernization, these are the ways to further stabilize the economic development of urban and rural areas, coordinate the social contradictions between urban and rural areas, protect regional ecological environment and promote the sustainable development of urban and rural areas.

The current academic research on urbanization and agricultural modernization mainly focuses on the qualitative analysis of the interaction between the two, but the inner mechanism of the influence of agricultural modernization on urbanization is still lack of deep excavation. Taking Wuhan City as an example, based on the statistical data from 1995 to 2012, this paper analyzed the relationship between agricultural modernization and urbanization by typical correlation analysis, then reveals the impact on population urbanization, economic urbanization, social urbanization and land urbanization level in the process of urbanization by agricultural input, agricultural output, rural social development and sustainable agricultural development in the process of agricultural modernization. It may help coordinating the relationship between agricultural modernization and new urbanization.

  DOI: 10.25236/ssehr.2018.112

2. Research areas and data sources

The data in this paper mainly include the measurement index of urbanization level and agricultural modernization level in Wuhan. Specifically, it mainly includes the urbanization rate of Wuhan City, the proportion of added value to GDP in the secondary and the tertiary industry, the average food and total consumption expenditure per person of urban and rural households monthly, the area of urban coverage, the area of cultivated land, the amount of agricultural chemical fertilizer, the amount of pesticide use, the total power of agricultural machinery, the area of effective irrigation lands, the area of sown lands, the number of the employed population in the primary industry, the total output value of the agriculture, forestry, pasturage and fishery, the average net income per capita of the rural households, the rural electricity consumption and the area of the crops affected lands, all of which came from the Wuhan statistical yearbook from 1996 to 2013.

3. Research methods

This paper selects a representative index from each four aspects of population urbanization, economic urbanization, social urbanization and land urbanization by the composite index method, then analyzes the relationship between the various aspects of agricultural modernization level and urbanization level. In particular (Table 3.1), this paper chose the urbanization rate as the measure index of population urbanization, the proportion of added value to GDP in the secondary and the tertiary industry as the measure of economic urbanization, the Engel coefficient of urban residents as the measure index of the social urbanization, and the area of urban coverage as the measure index of land urbanization.

The indicators that reflect the input level of agricultural modernization include the amount of agricultural chemical fertilizer, the amount of pesticide use, the total power of agricultural machinery in unit area of cultivated land, the effective irrigation rate and the proportion of the employed population in the primary industry. The indicators that reflect the output level of agricultural modernization include the labor productivity, the productivity of cultivated land and the total output value of the agriculture, forestry, pasturage and fishery.

In this study of this paper, canonical correlation analysis had been used to reveal the relationship between all aspects of agricultural modernization and urbanization. Two groups of variables had been set first, one was dependent variable group Y (Y1, Y2,…,Yp) to measure the level of urbanization and the other one was independent variable group X (X1, X2,...,Xq) to measure the level of agricultural modernization. Second on the basis of first step, the coefficients a_{kj} and b_{kj} of the linear combination had been figure out through the observation values of X_{ij} and Y_{ij}, and also the linear combination of two sets of variables, from which the new variables U_k and V_k were obtained. Third typical loads a_{kj} and b_{kj} had been got on basis of step above, and also the correlation variables U_k and V_k and the correlation coefficient r_k. The relationship between the two groups of variables [14] had been revealed last through all the steps.

$$\begin{cases} U_k = \sum_j a_{kj} x_j = a_{k1} x_1 + a_{k2} x_2 + \cdots + a_{kq} x_q \\ V_k = \sum_j b_{kj} x_j = b_{k1} x_1 + b_{k2} x_2 + \cdots + b_{kp} x_p \end{cases} \tag{1}$$

4. Result analysis and test

The higher the canonical correlation coefficient is, the closer the typical variable is. The canonical correlation coefficients of four pairs of typical variables in this study are 0.999, 0.988, 0.960 and 0.878, especially the first two pairs are very high, which indicate that the independent variables can clearly explain the variation trend of the dependent variables.

Table 1 the index system of canonical correlation analysis between urbanization and agricultural modernization

First level index	Second level index	Third level index	Attribute
Urbanization level	Population urbanization	Urbanization rate	Positive index
	Economic urbanization	Proportion of added value to GDP in the secondary and the tertiary industry	Positive index
	Social urbanization	Engel coefficient of urban residents	Negative index
	Land urbanization	Area of urban coverage	Positive index
Agricultural modernization level	Input level	Amount of agricultural chemical fertilizer	Positive index
		Amount of pesticide use	Positive index
		Total power of agricultural machinery in unit area of cultivated land	Positive index
		Effective irrigation rate	Positive index
		Proportion of the employed population in the primary industry	Positive index
	Output level	Labor productivity	Positive index
		Productivity of cultivated land	Positive index
		Total output value of the agriculture, forestry, pasturage and fishery	Positive index
	Social development level	Engel coefficient of rural residents	Negative index
		Average net income per capita of the rural households	Positive index
		Rural electricity consumption	Positive index
	Sustainable development level	Area of crops affected lands	Negative index

The results of canonical correlation analysis (table 2) showed that variables with larger absolute load values played a decisive role in typical variables. In the first typical variables group, the urbanization rate representing population urbanization and proportion of added value to GDP in the secondary and the tertiary industry representing economic urbanization were separated from the dependent variables, and the typical loads were -0.988 and -0.963 respectively. The variables corresponding were the total power of agricultural machinery in unit area of cultivated land representing agricultural input level, the Engel coefficient of rural residents and the average net income per capita of the rural households representing social urbanization from the independent variables, the typical loads were -0.970, 0.929 and -0.943 respectively. Among these indexes, typical load of the Engel coefficient of the rural residents was positive, but it was a negative index. As a result the two indexes representing urbanization level are positively related to the three representing agricultural modernization level, which means the level of population urbanization and economic urbanization will be improved with development of agricultural mechanization level and agricultural society level.

Table 2 typical loads of variables in urbanization and agricultural modernization

Code	Variable name	Typical variable 1	Typical variable 2	Typical variable 3	Typical variable 4
Standard variable group Y - Urbanization level					
Y1	Urbanization rate	-.988	-.103	.071	.084
Y2	Proportion of added value to GDP in the secondary and the tertiary industry	-.963	.236	.108	-.074
Y3	Engel coefficient of urban residents	.680	-.440	.204	.550
Y4	Area of urban coverage	-.870	-.223	.439	.005
Independent variable group X - Urbanization level					
X1	Amount of agricultural chemical fertilizer	-.774	.481	-.071	-.077
X2	Amount of pesticide use	-.625	.257	.284	.115
X2	Total power of agricultural machinery in unit area	-.970	-.174	.009	-.047
X3	Effective irrigation rate	.818	-.365	.118	-.123
X4	Proportion of the employed population in the primary industry	.923	.141	-.146	.027
X5	Labor productivity	-.916	-.301	-.039	.035
X6	Productivity of cultivated land	-.914	-.337	-.094	-.001
X7	Total output value of the agriculture, forestry, pasturage and fishery	-.890	-.392	-.006	-.007
X8	Engel coefficient of rural residents	.929	-.017	-.076	-.161
X9	Average net income per capita of the rural households	-.943	-.214	.104	.040
X10	Rural electricity consumption	-.899	.298	.058	.011
X12	Area of crops affected lands	.743	-.409	.122	.167

5. Conclusion and discussion

Taking Wuhan as an example, this paper selected some representative indexes of urbanization level and agricultural modernization level respectively, and analyze the influence of various aspects of agricultural modernization level on urbanization level by the use of canonical correlation analysis. The results showed that:(1)urbanization level is affected by agricultural input level, social development level and sustainable development level, but not significant by the agricultural output level;(2)urbanization process is affected by agricultural modernization level includes all aspects of urbanization, including population urbanization, economic urbanization, social urbanization and land urbanization; (3)the improvement of agricultural mechanization level in agricultural input level and agricultural social level could increase the population urbanization and economic urbanization in the process of urbanization;(4) the increase of the agricultural inputs consumption and the promotion of agricultural sustainable development could improve the social urbanization level; (5) the expansion of land urbanization could be improved with the increase of agricultural material consumption.

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