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Interactive Relationship among China's "Four New Modernizations"

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Abstract

The report on the 18th session of the National People's Congress first proposed that we should promote the simultaneous development of industrialization, informatization, urbanization and agricultural modernization. "Four New Modernizations" are the basic contents of China's modernization. They influence each other, cooperate with each other, accelerate with each other and jointly promote social and economic development. This paper summarized an interaction model based on the analysis of interactive mechanism among industrialization, informatization, urbanization and agricultural modernization. Meanwhile, we measured and evaluated their interactive relationship by using Entropy Method and Granger Causality Test Method. Results show that there exists positive interaction between China's industrialization & informatization, industrialization &urbanization, urbanization & informatization, urbanization & agricultural modernization, each couple can influence each other while the industrialization and agriculture modernization, informatization and agricultural modernization failed to achieve the mutual interaction.

JEL classification numbers: O14, Q1
Keywords: "Four new modernizations", Interactive relationship

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1 Introduction

The report on the 18th session of the National People's Congress summarized china's next economy developmental path as "synchronization of four modernizations", which means we must adhere to the path of industrialization, informatization urbanization and agricultural modernization with Chinese characteristics and promote the simultaneous development of industrialization, informatization, urbanization and agricultural modernization. Compared with the traditional "Four Modernizations", "Four New Modernizations" gives new connotation to modernization in the new age and they are correlative and indivisible. Only the simultaneous development of "four new modernization" be realized, can we fulfill the target of china's socialist modernization construction.

In recent years, most domestic scholars focused on the interactive development of industrialization, urbanization and agricultural modernization. The research contents concentrated upon the interaction relation of the three modernizations, policy measures which can promote the interactive development of "the three" and empirical study of "the three", e.g. Chengjie Yin (2011)[1] , Xinwen Chen(2011) [2]、Hui Chen（2012）[3]、Zhanqiang Zhou、Zhimin Qiao(2012)[4]、Zhenming Wu(2012)[5] etc. A few scholars did in-depth theoretical study about the interactive relationship between the three modernizations. Ailin Jiang(2002) [6], but empirical analysis are not included. That means so far there is no literature that takes the interactive relationship between the "Four New Modernization" as the study object to formulate and do quantitative measure. Considering both theory and empirical aspects ,based on the exploration of the "Four New Modernizations" theoretical model and using china's time series data from 1985 to 2011, this paper sets up the "Four New Modernizations" index system and evaluates china's current "Four New Modernizations" by using Entropy Method and Granger Causality Test Method.

2 Theoretical Model

Industrialization, informization, urbanization and agricultural modernization are the basic content of modernization. Four of them influence ,cooperate and promote with each other , and they can finally promote the development of the society and economy as a whole. Firstly, it is the traditional agriculture holds the dominant position. The economy is in a closed state and industrialization and urbanization develop slowly. Then the labor intensive industry and capital intensive industry develop rapidly and second industry replaces agriculture as the dominant industry, which induces labor and capital to gather in the city and promote the development of urbanization. Later with the rapid development of high-new-tech industries, modern service industries and the information industries, the pace of urbanization becomes slow but cities form reticular distribution. The layout becomes more reasonable and the service function of the city becomes more powerful. "Four New Modernizations" is a complicated, closely connected and multi-layered system. Only all the subsystems cooperate with each other, can the harmonious development be achieved.

2.1 Interactive Relation Mechanism

2.1.1 Interactive Relation Mechanism of Industrialization and Urbanization

Firstly,Industrialization drives urbanization.Industrialization and urbanization mutual effect with each other and develop altogether. Industrialization drives urbanization and urbanization is the inexorable outcome of industrialization. [7] This relationship can be reflected in following points: 1.During the industrial production process there are economies of scale and scope economy. This rule necessarily leads industries, labor force and capital gathering in certain regional space, which provides source power for urbanization; 2.Rural surplus labor migration is accompanied with industrialization, scientific and technological progress and industrial structure optimization are conducive to the development of urbanization; 3.The growth of industrial output , development of economic benefit and enhancement of industrial agglomeration effect can promote the expansion of cities and the service function of the city. And the human settlement will also be optimized.

Secondly,Urbanization promotes industrialization.The industrial agglomeration effect, scale effect, externality and location effect that urbanization possesses can promote the industrialization development and at the same time make cities become the basement of modern society. We can analyze from the following points: 1. Urbanization is the foundation of industrialization and provides space support for industrial structure transformation; 2. With the expansion of urban population, a huge potential consuming market would be formed, which can boost the demand for domestic industrial products. 3. Plenty of professional talents are absorbed by cities and they are the sufficient manpower for industrialization; 4. Cities have relatively sophisticated public infrastructures and service facilities, which can meet the industrial demand for water, electricity, consultation, communication, law and other supporting facilities and services.

2.1.2 Interaction Mechanism of Industrialization and Informazition

Firstly,Industrialization supports informatization.Industrialization is the material basis and marketing basis for informatization. In other words, without industrialization, there is no informatization[6]. This can be explained from the following two points: 1. Industrialization is a long-term and continuous progressive process during which there is a complex series development of economy and social relations as a whole. Industrialization revolution gives birth to information technology. Besides, the development of industry provides capital accumulation and production conditions for information technology and application. All of these can be reflected as material support for informization; 2. The improvement of industrialization would effectively stimulate the demand for information technology, applications and services. And then the ability of information integration technology would be improved. This can be reflected as industrialization provides market support for informization.

Secondly,Informatization promotes industrialization.Informatization is the continuation of industrialization and provides a strong driving force for it. This impact can be reflected as the following points: 1. Informatization enriches the connotation and meaning of industrialization and can promote future development of industrialization. Informatization can also drive the rapid development of a series information technologies and industries such as multimedia technology, communication technology, Intelligent computer technology and interactive network technology. 2. Information technology can reform

traditional industry and make industry achieve automation and intellectualization. At present, information technology has become the technological base of industrial modernization and agricultural modernization. It also dominates the industrialization direction in the new period and makes the industrialization in the direction of the high added value and sustainable development.

2.1.3 Interaction Mechanism of Industrialization and Agricultural Modernization

Firstly, Industrialization improves agricultural modernization.The function channels for industrialization to improve agricultural modernization are the labor transfer and aggregation, the progress of science and technology and the optimization and upgrading of industrial structure. [8] First of all, industrialization induces a large number of rural surplus labor to the city. Gradually agricultural production transforms toward intensification, specialization and scale, which would effectively improve the production and economic benefits of agricultural industry. Secondly, the advance of science and technology can benefit agricultural section, drive technology innovation in the agricultural field and help agriculture industry upgrade. Thirdly, Industrialization can promote agricultural division to the direction of specialization, refinement and rationalization. It can also speed up the agriculture structure adjustment and the agricultural production efficiency and the value would be raised. The competitiveness of agriculture would be improved; Besides, industrialization can provide modern means of production for agricultural modernization, such as agricultural machinery, pesticide, fertilizer, information application platform. All of them can change the development pattern of traditional agriculture. Finally, industrialization can provide financial support for agricultural modernization.

Secondly,Agricultural modernization supports industrialization.Food security is the fundamental guarantee of the national economy development. [9]It is the most outstanding embodiment of agricultural modernization supporting industrialization. Meanwhile, agricultural modernization can provide sufficient labor supply for industrialization. The advancement of agricultural modernization means agricultural production and operation develop to the direction of intensification, specialization and scale. It also means that agricultural surplus-labor moves from agricultural sector to non-farm business sector and turns to be strong support for industrialization. 2. Agricultural modernization provides raw material support for industrialization. With the improvement of agricultural productivity and usage efficiency, agricultural modernization would provide more plentiful and abundant raw materials.

2.1.4 Interaction Mechanism of Urbanization and Informatization

Firstly,Urbanization supports informatization.Urbanization is the supporter and carrier for informatization. Firstly, urbanization can provide informatization enough space. Information technology and information industry need enough space and urbanization can provide them enough space. Secondly, urbanization can provide informatization market support. The city’s reception and absorption capacity to Information technology, communication technology, information industry and information technology products can provide a steady stream of driving force for informatization.

Secondly,Informatization improves urbanization.Informatization can improve urbanization in all directions. Informatization can not only greatly affect the process of urbanization, but also promote urban and rural spatial structure optimization. Firstly,

Modern information technology of communication provides methods for the rapid accumulation of commodity, manpower, technology and information, which can improve the urban functions and perfect the urban industrial structure and employment structure. The quality of residents would be improved and lifestyles and consumption patterns of urban and rural residents would also be changed. Secondly, information infrastructure would efficiently equip urban infrastructure system and help the city's construction, planning and management realize modernization, informatization and intelligentization. Thirdly, with the universal use of modern information technology, especially communication technology, regional boundaries would become increasingly blurred, which can accelerate the process of the resources flow and urban- rural integration.

2.1.5 Interaction Mechanism of Urbanization and Agricultural Modernization

Firstly,Urbanization drives agricultural modernization.Agricultural modernization relies on urbanization and urbanization drives agricultural modernization. This can be reflected on the following five points: 1. Urbanization can accelerate the migration of surplus rural labor force. With the improvement of all kinds of industries in the city, surplus rural labor force continuously move to non-agricultural industries, making the per capita occupancy of cultivated land boost. Thus the production and operation of rural land would gradually realize intensification and large-scale and the agricultural productivity would also boost; 2. Urbanization would improve ventures in agroindustry and tertiary industries. Since all these industries have major relevancy with agriculture , they can provide standardized service for agriculture ,in the period of before, during or after production.3. Urbanization can help optimize industrial structure. Urbanization would generate huge potential consuming market, and the demand for diversified agricultural products increases. All these would stimulate product structure and industrial structure to be optimized and help agricultural products develops in the direction of diversification, high quality and high added value; 4. Urbanization provides agricultural modernization capital support and technical support. Many excellent township enterprises can provide capital and technical support for agricultural modernization. They would also drive agricultural mechanization and popularization of agricultural science and technology. 5. The public infrastructure in the city stretches toward rural area gradually, which can facilitate production mode and lifestyle transformation. The famers' living standards and rural living environment would be improved. Urban and rural integration would also be promoted.

Secondly,Agricultural modernization supports urbanization. Agriculture industrialization can drive the level of urbanization. This is reflected on the following two aspects: 1. With the continuous improvement of agricultural productivity, a large amount of surplus agriculture products will be generated. This on the one side can boost the agricultural production support and the increasing demand for agricultural products would be met. On the other side some farmers can shift from agricultural sectors to non-agricultural industries. Therefore agricultural products surplus is the very fundamental condition for urbanization; 2. The consumption level of rural residents would increase with the increase of their income. Besides, agricultural modernization itself needs a large amount of industrial products, such as agricultural machinery and fertilizer. So this would motivate some related industries develop rapidly and this process would play a supporting role to urbanization.

2.1.6 Interaction Mechanism of Urbanization and Agricultural Modernization

Firstly, Informatization supports agricultural modernization.Informatization is an important supporter for agricultural modernization and at the same time is the effective means to realize agricultural modernization. This can be explained from the following two points: 1. Informatization makes agricultural scientific decision-making possible[10]. Information based computer technique and decision support system can provide sufficient gist for agricultural scientific decision, and can improve procedural, scientific and intelligent level of agricultural decision. Information and technical advisory services would have increasingly important position in the whole agricultural sector. 2. Information Technology Application System is the significant accomplishing means to agricultural high-tech development and application. Based on networking platform, Information Technology Application System is the significant accomplishing means to modern agricultural mechanization, planting and cultivation technique, agricultural products processing and storage technology, agricultural biotechnology, agricultural natural disaster prevention and control monitoring technology, agricultural resources and environment control technology, etc.3. The movement and sale of modern agricultural products base on the Internet information technology. With the rapid development of economic globalization, the agricultural products online trade using internet and Information technology means has been becoming the ordinary state of modern agricultural products trade; 4. Informatization help improve farmers' comprehensive quality. Because information service allow farmers to get more information and new behavior consciousness, ideology and thinking mode can be continuously formed, they would turn to high-quality farmers.

Secondly,Agricultural modernization drives informatization.With the development of agricultural modernization, the demand from agricultural sector for information would become increasingly strong. Modern agriculture would generate dependency on Information technology and services in the respects of planting and cultivation technique, transportation and storage, sales and docking, production equipment, production decisions, etc. Informatization would continuously develop in order to satisfy these needs. Informatization would be used in broader fields and the cost of informative application would decline gradually, and the all-round development of informatization would be promoted.

2.2 Theoretical Model Building

After analysis and discussion above, it is evident that “Four New Modernization” influence, cooperate and promote with each other. There is interactive relationship between them.This theoretical model can be concluded as the following points:

Firstly,It is the social division of labor that made the industry and the city divide from agriculture. The industrial revolution made production method change fundamentally and leaded the development of urbanization. To be precise, industrialization creates supply, urbanization generates demand. Industrialization is the basis and driving force of urbanization and, conversely, urbanization continuously promote the industrialization.

Secondly,Informatization is the output of the Community & Economic development and is the result of mutually promotion between industrialization and urbanization. Industrialization provides economy basis for informatization and urbanization provides social basis for informatization.

Thirdly,Industrialization and urbanization conversely promote agriculture by equipping modern agriculture. Agricultural modernization provides support for industrialization, informatization and urbanization.

Finally,Informatization drives industrialization, urbanization and agricultural in the following ways. Industrial transformation and upgrading can be realized by deep integration of informatization and industrialization. The construction of informational city can promote urban function. The farmers' production mode and lifestyle would be changed by agricultural informatization .

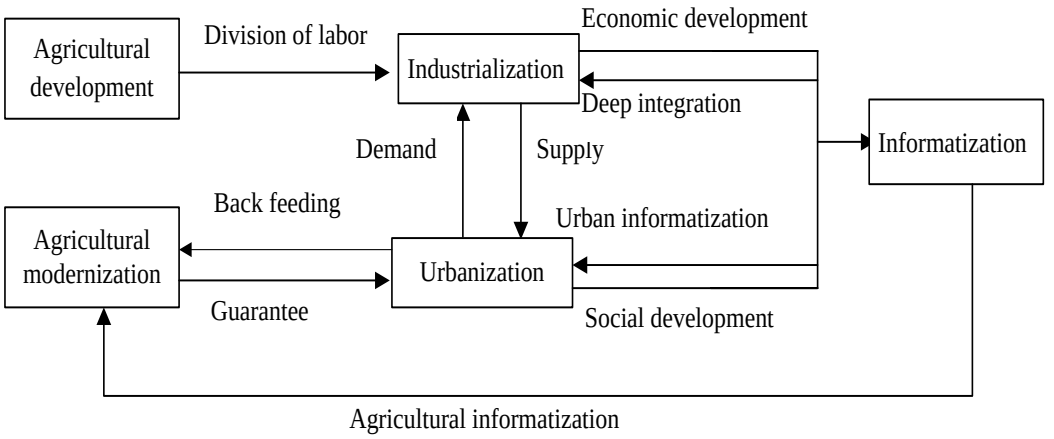

Figure1: Theoretical model of china's "Four New Modernizations"

3 The Measurement of China's "Four New Modernizations" Developmental Level

Chinese eighteenth national congress gave "Four New Modernizations" richer connotation. Following the principles of systematicness, scientificity, practicability and maneuverability and by picking typical indicators to design index system , this paper measures the developmental level of industrialization, informatization, agricultural modernization and urbanization.

3.1 The Design of Evaluation Index for each Subsystem

The measurement index of industrial development level reflects the connotation of new industrialization, including per capital GDP, the proportion of the non-agricultural industry added value in GDP, the output value of comprehensive utilization of "three wastes" products, full-time equivalent of the R&D personnel, rate of reaching the standard of discharged industrial waste water, etc. And there are eight indicators; The indicators used to measure the informatization developmental level are phone popularizing rate, television program coverage rate, electronic information industry added value, etc. And there are seven indicators ; In order to make sure the urbanization level can fully reflect the quality of urbanization, this paper chooses nine indicators and they are urban registered unemployment rate, Engel coefficient of urban households, urban per capital disposable income, urban per capita living space; Based on the current situation of china's

agricultural modernization, this paper chooses the total power of farm machinery, effective irrigation area, total sown area, per capita output of grain, the proportion of first industrial added value in GDP. And there are ten indicators.

3.2 Evaluation Method Description

Entropy is a comprehensive evaluation method for multi-object and multi-index system[12]. It's based on the amount of information of each index transmitted to the decision-makers to determine the size index weights. The results obtained from Entropy method are based on the index itself. So it can overcome the overlap of information between multiple variables and human subjectivity of determining the weight, making evaluation system more scientific and reasonable.

3.3 Data Source Description

The data used in this paper is from "China Statistical Yearbook" (1985-2011) and Chinese statistics database. According to national accounts, industry, agriculture, science and technology activities, national lives and other relevant statistical data from "China Statistical Yearbook" (1985-2011), data is collected and calculated for evaluation index system.

3.4 Evaluation Results and Analysis

Based on the weights calculated by using Entropy method, measure scores of Chinese industrialization developmental level, informatization, urbanization and agricultural modernization are calculated by using Matlab software each year from 1985 to2011.

Table 1: Indicator system and weight of "New Four Modernizations"

Level 1 indicators	The secondary indicators	weight
evaluation index for industrialization	A1 Per Capita GDP （yuan）	0.0906
	A2Proportion of added value of non-agricultural industries in GDP %	0.1175
	A3The proportion of non-agricultural industries employees in all %	0.1046
	A4 Comprehensive utilization of "three wastes" product output （ten thousand yuan ）	0.0893
	A5The number of domestic authorized invention （term）	0.0812
	A6 R&D personnel of full-time equivalent (person、year ）	0.3085
	A7The proportion of Large and medium-sized industrial companies%	0.1061
	A8the rate of discharged industrial wastewater that reached the standard%	0.1022
evaluation index for informatization	B1penetration rate of telephone （a phone/a hur	0.1402
	B2 penetration rate of mobile phone (a phone/a hundred persons)	0.1353
	B3 television program coverage rate %	0.1556
	B4 broadcasting program coverage rate %	0.1547
	B5 Manufacturing industry of electronic information industry added value （a hundred million yuan）	0.1362
	B6 Manufacturing industry of electronic information industry	0.1389

	employees (ten hundred	
	B7 Manufacturing industry of electronic information industry total profit (hundred million yuan)	0.1391
	C1The proportion of urban residents %	0.1029
	C2The rate of registered urban unemployment %	0.1133
	C3 Engel coefficient of urban households	0.1075
	C4 Per capita disposable income of urban households (yuan)	0.0952
	C5 Urban per capita road area (square meter /per	0.1005
evaluation index for urbanization	C6the number of buses that per ten thousand people have (one bus/ten thousand people)	0.1001
	C7the number of students that in higher leaning institutions (t people)	0.0951
	C8 City water penetration %	0.1029
	C9the number of medical beds that per ten thousand people have (one bed)	0.0839
	C10Urban per capita living area(square meter)	0.0986
	D1total power of agricultural machinery (ten thousa	0.0932
	D2effective irrigation area (one thousand hectares)	0.1015
	D3applying quantity of chemical fertilizer (ten thousan	0.1071
	D4rural power consumption (TWh)	0.0903
	D5 installed capacity of hydropower station that are set up by village office (ten thousand kilowatt)	0.0779
evaluation index for agricultural modernization	D6 Total Sown Area (one thousand hectares)	0.1037
	D7 per capita output of grain (kilogram /per person)	0.1074
	D8 Per unit area grain yield (kg/ha)	0.1107
	D9the proportion of first industry employees%	0.1114
	D10 The proportion of first industrial added value in GDP%	0.0968

Table 2: The score of developmental level of china's "New Four Modernizations" from 1985~2011

	Industrialization		Informatization		Urbanization		Agricultural modernization	
	score	order	score	order	score	order	score	order
1985	0.0012	27	0.0011	27	0.1387	25	0.1284	27
1990	0.0378	24	0.1526	20	0.1348	26	0.2784	21
1995	0.1613	17	0.1856	17	0.2189	17	0.3627	17
2000	0.3642	12	0.4073	11	0.372	12	0.4352	14
2003	0.4424	9	0.4684	9	0.5275	9	0.4078	16
2004	0.4582	8	0.5507	8	0.5757	8	0.4973	8
2005	0.5302	7	0.6648	7	0.6205	7	0.5419	7
2008	0.7268	4	0.8754	4	0.75	4	0.7311	4
2010	0.8853	2	0.9547	2	0.83	2	0.83	2
2011	0.9669	1	1	1	0.8923	1	0.9032	1

From the horizontal comparison of four systems, the level of industrialization

development has maintained rapid growth from 1985-2011, while the level of informatization development lagged behind industrialization, urbanization and agricultural modernization until 2000 years, when informatization was booming in China. The level of urbanization is also rising steadily, but the speed of development is slow. Since 2004, the growth rate of the level of urbanization and agricultural modernization has significantly lagged behind the level of industrialization and informatization.

4 The Measurement and Evaluation

Granger Causality Tests is used to identify if lag variable has impact on other variables. If one variable was affected by other log variables, they would have a Granger causality. [13] This paper adopts Granger Causality Tests to checkout if there is interactive relationship between industrialization, informatization, urbanization and agricultural modernization. The result is shown in table 3-8.

4.1 Unit Root Test

Using the results of the score above, this paper conducts Granger causality test for china's "Four New Modernizations". The developmental level of industrialization is recorded as *ind.* The developmental level of informatization is recorded as *inf.* The developmental level of urbanization is recorded as *urb*. The developmental level of agricultural modernization is recorded as *farm*. In order to eliminate the the index data non-stationary and possible heteroscedasticity that was caused by economic fluctuation, four variables are treated as logarithmetics respectively. And they are recorded as *lnind*，*lninf*，*lnurb*，*lnfarm.* The corresponding difference sequence are recorded as *dlnind, dlninf, dlnurb, dlnfarm.* And as their variation tendency is Similar to that of *{ind},{inf},{urb},{farm}*, they can show the volatility. By using Eviews6.0 and ADF test method to analysis the stability, the result is shown in table 3.

Table 3: Unit root test of variables

Variable	ADF statistics	critical value		Check Result
$\ln ind$	-5.3313	-2.9810	（5%）	stationary
$\ln inf$	-7.2532	-2.9810	（5%）	stationary
$\ln urb$	0.3234	-2.9810	（5%）	Non-stationary
$\ln farm$	-1.3841	-2.9810	（5%）	Non-stationary
$d \ln ind$	-17.4980	-3.7241	（1%）	stationary
$d \ln inf$	-30.9059	-3.7241	（1%）	stationary
$d \ln urb$	-4.5297	-3.7241	（1%）	stationary
$d \ln farm$	-4.8131	-3.7241	（1%）	stationary

From table 3 we know that *lnind, lninf* are stationary variables and *lnurb*，*lnfarm* are non-stationary variables. But after first difference, *dlnind, dlninf, dlnurb,dlnfarm are* all stationary variables. So we can see that *lnurb,lnfarm* are integrated of order non-stationary variables. Granger causality test between *lnind, lninf and dlnind, dlninf, dlnurb, dlnfarm* can be conducted.

4.2 Granger Causality Test

The result of Granger causality test can reflect the interactive relationship between invariables. The result is shown in table 4:

Table 4: Granger causality test

	null hypothesis	P	conclusion
$\ln ind$ / $d\ln ind$ equation	$\ln inf$ is not the Granger cause of $\ln ind$	0.0001	refuse
	$d\ln urb$ is not the Granger cause of $d\ln ind$	0.0000	refuse
	$d\ln farm$ is not the Granger cause of $d\ln ind$	0.0764	refuse
$\ln inf$ / $d\ln inf$ equation	$\ln ind$ is not the Granger cause of $\ln inf$	0.0013	refuse
	$d\ln urb$ is not the Granger cause of $d\ln inf$	0.0891	refuse
	$d\ln farm$ is not the Granger cause of $d\ln inf$	0.4695	accept
$d\ln urb$ equation	$d\ln ind$ is not the Granger cause of $d\ln urb$	0.0251	refuse
	$d\ln inf$ is not the Granger cause of $d\ln urb$	0.0000	refuse
	$d\ln farm$ is not the Granger cause of $d\ln urb$	0.0991	refuse
$d\ln farm$ equation	$d\ln ind$ is not the Granger cause of $d\ln farm$	0.1070	accept
	$d\ln inf$ is not the Granger cause of $d\ln farm$	0.0429	refuse
	$d\ln urb$ is not the Granger cause of $d\ln farm$	0.0163	refuse

According to the result of table 4, it is not hard to see from 1985-2011 that there is a bidirectional causality between industrialization and informatization, industrialization and urbanization, informatization and urbanization, urbanization and agricultural modernization. Informatization is the granger cause of agricultural modernization, but agricultural modernization is not the granger cause of informatization. Agricultural modernization is the granger cause of industrialization, but industrialization is not the granger cause of agricultural modernization. It means that there is good interplay between industrialization and informatization, industrialization and urbanization, urbanization and informatization, urbanization and agricultural modernization in the process of development. They can influence each other. But industrialization and agricultural modernization, informatization and agricultural modernization did not realize benign interaction.

5 Conclusion

It's easy to see that, because the development policy of only concentrating on industry and neglecting agriculture was put into effect during a long period after the founding of our country, Three Rural Issues has left and industrialization not only did not promote agricultural modernization, instead, it is a disincentive. Meanwhile, China's agricultural information construction is still in the exploratory stage, so agricultural modernization can't play a catalytic role on the development of informatization. Therefore, the policy recommendations is to accelerate the development of China's agricultural modernization,

increase government support, give full play to industry nurturing agriculture and promote rural towns role; rise the urbanization rate and at the same time promote greater attention to the quality of urbanization; we should realize great-leap-forward development of agricultural modernization by agricultural informatization. We should also continue to steadily promote the the depth integration of industrialization and informatization, which can lay a solid foundation for China's modernization.

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