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A Study of Relationship between Water Conservancy Facilities and Grain Yield Based on VAR Model

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Abstract: Water conservancy facilities play a vital role in rural economic development and social stability, which are the foundation of national food security guarantee. Practice has proved that investing in agricultural infrastructure can not only promote the growth of agricultural output but also narrow the gap between the rich and the poor. In this paper we will establish a VAR model of water conservancy facilities in Haikou and grain yield to analyze the affecting factors between them, and make some recommendations to make the most of water conservancy facilities in Haikou to increase the local food production.

Introduction

At present, Haikou is fully repairing water conservancy facilities to improve its water saving and drainage irrigation ability, which lead to 14 million mu added and 130 million mu improved irrigated areas. As most of existing large irrigation areas were built in 1950s—1970s, plus Haikou is in socio-economic transformation period, without scientific planning, financial support and proper management, many water conservancy facilities are working in poor conditions[1]. At the same time plenty of issues are appearing, which adversely affect them and decrease food production.

Methodology

Model And Data Selection

To fulfill the objective of this study, the data of annual grain yield(Y_1), the amount of irrigation machinery(X_1), quantities of pumps(X_2) and effective irrigated area(X_3) from Haikou statistical yearbook are collected to analyze the relationship between water conservancy facilities and grain yield.

Table 1 Selected data

TIME	X_1（thousand）	X_2(thousand)	X3(thousand ha)	Y1(thousand tons)
2001	12.14	2.15	13.28	129.10
2002	13. 14	3.19	14.46	130.11
2003	15.72	3.72	15.68	133.89
2004	17.60	4.48	16.23	137.40
2005	17.65	5.12	16.32	138.80
2006	18.61	6.61	17.12	141.87
2007	18.47	6.68	17.56	142.34
2008	18.61	6.90	17.58	145.03
2009	18.61	7.53	17.84	148.80
2010	18.91	8.49	17.89	153.26
2011	19.00	8.59	18.31	155.84
2012	19.28	8.62	18.31	156.91

2013	20.21	8.97	18.34	157.65
2014	21.23	9.07	18.35	158.91
2015	22.90	9.18	18.87	161.63
2016	23.14	9.53	19.61	162.64

VAR model is vector autoressive model put by Sims in 1980, which can be described as follow[2]:

$$Y_1=A_1Y_{t-1}+\ldots..+A_pY_{t-p}+B_x+\mathscr{E}_t \qquad t=1,2,\ldots\ldots..,T \qquad (1)$$

Y_t is the endaogenous variable vectors of h dimensions, X_t is the exogenous variables of k dimension, p is lag order and T is the numble of samples. H*h dimensional matrix A1,..., the A_p and h*k dimension matrix B is estimated coefficient matrix, and $\mathscr{E}_t$ is perturbation vertor of k dimension. All of them can relate to that over the same period, but they aren't related to the variables on the right of the equation. The model isn't concerned with the signiticance of variance regression coeffcient, and the key is the model's stability level. Based on the stability of VAR system, impulse response and variance decomposition can be used to study the dynamic impact of random perturbation on variable system. In addition, to eliminate the variances that may exist in each variable, we model natural variables after logarithms and all of them can be described as $In(Y_1)$, $In(X_1)$, $In(X_2)$ and $In(X_3)$.

Analysis Of Relationship Between Grain Yield And Water Conservancy Facilities

Impulse response is an important aspect of the dynamic characteristics of VAR model, which depicts the movement of each variable or the trajectory of impact on itself and all other variables. And it presents the positive and negative effects of each influencing factors through the pulse response diagram as well[3]. According to the amount of samples, the impact response period is set to 10. And plotting the impulse response curve of Y_1 to X_1, X_2 and X_3 and analyzing the trajectory of crop volume to determine the effect of water conservancy facilities on the yield of different crops.

The curve $\ln X_1$ is the pulse response trajectory of the amount of irrigation machinery for grain crop yield. When X_1 put a standard deviation on Y_1, the grain yield shows a clear positive reaction in 3-6 periods but shows a negative reaction after 6th periods. Then the positive and negative effects occur alternately, but the impact becomes weaker, the final region converges. That is to say the amount of irrigation machinery increase the grain yield at first, but it turns bad in 6th periods. Although the amount of irrigation machinery is increasing, due to the lack of management and maintenance, the impact on grain yield is becoming weaker.

The curve InX_2 is the pulse response trajectory of quantities of pumps for grain crop. When X_2 gives Y_1 a standard deviation, the grain crop shows negative in the 1-3 periods but such impact is trend to be weaker. Then the positive reaction appears in the 3th period and last long time, and the positive and negative effects occur alternately, but the impact becomes weaker, the final region converges. This is to say that the improvement of quantities of pumps has certain promotion effect on grain crop yield, but the promotion action has limitation. Although the constantly being perfected, the lack of management is weakening its positive impact on grain yield.

The curve InX_3 is the pulse response trajectory of effective irrigation area for grain crop. The increment of effective irrigation area has negative reaction to the impact of grain yield only in 4-5 periods. But the overall trend is positive, which gradually tends to zero. This is to say that the increment of effective irrigation area is improving the food production.

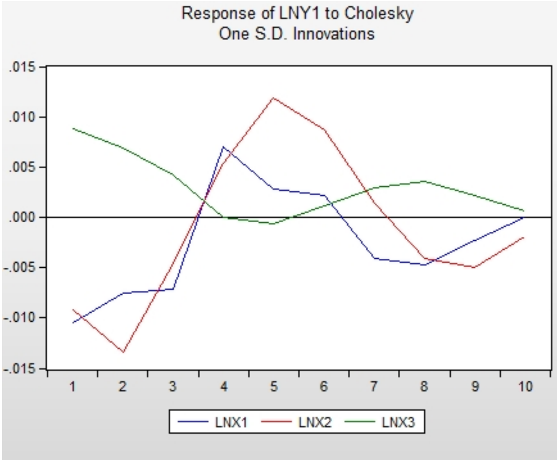

Fig. 1 Figure of impulse response

Table 2 Results of din(Y_1)'s impulse response function

period	LnX_1	LnX_2	LnX_3
1	-0.010529	-0.009147	0.008804
2	-0.307558	-0.013459	0.006944
3	-0.007179	-0.004645	0.004227
4	0.007021	0.005348	-5.34E-05
5	0.002753	0.011817	-0.000677
6	0.002123	0.008648	0.001092
7	-0.004074	0.001460	0.002970
8	-0.004761	-0.004120	0.003596
9	-0.002276	-0.004996	0.002206
10	-2.50E-05	-0.001945	0.000629

Variance Decomposition Analysis

Variance decomposition is a description method of system dynamics usually measured in terms of variance. And it evaluates the relative importance of different structural shocks by analyzing the contribution of each structural impact to the change of endogenous variables[4].

According to the impulse response function, the impact of every factor on grain yield concludes positive and negative reaction. But on the whole, the impact on food crops has leveled off in the latter stages. This is to say that the longer it lasts, the weaker effect of influencing factors on grain yield. In order to further quantitatively analyze the process of grain yield variation in long-term grain crops, we will carry out the variance decomposition for each influence factors.

The change in grain yield growth is gradually decreasing due to its own impact, from the initial 29.30% decline to 16.19%. In the long term the effect of effective irrigation area on crop yield impact is increasing, the effect of irrigation of the amount of irrigation machinery impact on it is almost constant and the effect of quantities of pumps impact on it is declining. In addition of 29.30% food production was determined by itself and the other factors affected by other factors: 25.36% of the amount of irrigation machinery, 45% of effective irrigation area and 13.43% of quantity of pumps. According to the result of variance decomposition analysis, the three variances have their own positive effect on grain yield, which verifies the fact that food production is linked to water resources and area.

Table 3 Results of din(Y_1)'s variance decomposition

period	S.E	LnX_1	LnX_2	LnX_3	LnY_1
1	0.024602	28.81461	21.74806	20.14777	29.28956
2	0.030172	23.12249	36.45001	17.30588	23.12163
3	0.033026	26.54450	34.62910	17.36297	21.46343
4	0.038192	29.66439	34.75835	15.84576	19.73149

5	0.038727	26.01436	42.78897	13.55813	17.63855
6	0.039002	24.57647	46.31877	12.70748	16.39727
7	0.039847	25.33716	45.26989	13.12127	16.27169
8	0.040190	25.86036	44.30426	13.48834	16.34704
9	0.040529	25.45787	44.87368	13.44774	16.22070
10	0.040815	25.36702	45.00853	13.43058	16.19387

Countermeasures and Suggestions

Establish An Efficient Investment Mechanism

The ministry of finance is support to increase investment in water conservancy facilities in local area and build new facilities to restore its normal operation function. Using the local cultural characteristics to establish a diversified investment mechanism and actively explore the rural water conservancy investment and financing system. Finally form a government-oriented diversification into the mechanism to promote economic development.

Promote New Water-saving Technology

Haikou is located at the north of Hainan province, where the flood and drought occurs frequently and crops can't get water in time. The application of agricultural water-saving technology such as drip irrigation can be promoted properly to improve the efficiency of grain production in irrigated areas, increase grain yield and reduce the strength of farmers. It can also reduce the cost of farming and raise the farmer's incomes.

Improve The Management System

Encourage farmers to pay for their voluntary contributions and work together to form a cooperative water cooperation organization to arrange, manage and preserve water conservancy facilities. And let the real beneficiaries be responsible for the management of those facilities to further improve farmers' awareness of management and protection to reduce artificial destruction.

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References

[1] Longwei Li, weikai Lei. Status of Irrigation Construction in Hainan and Relevant Countermeasurs[J]. Chinese journal of tropical agriculture, 2011,31(12):91-94+102.

[2] Shengnan Wu, Li Yanquan, Analysis of factors that influence forest vegetation carbon storage by using the VAR model: a case study in Shanxi Provinc [J].Academy of foresty, 2015, 35 (01) : 196-203.

[3] Zhang Z L, Sun H. Research on the dynamic relationship between water-intensive industrial and economic growth in Xinjiang on VAR model. Acta Ecologica Sinica [J/OL]., 2017,(16):1-12(2017-03-27)

[4] Yan yu-jie, Ren xuewen, Chen qiling. Problems and countermeasures of farmland water conservancy infrastructure construction in xianyang [J]. Modern agriculture, 2013,(01):80-81.