ISSN : 0974 - 7435 Volume 10 Issue 14

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(14), 2014 [8179-8184]

An empirical study on the relationship among water conservancy investment, construction of water conservancy facilities and agricultural development

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ABSTRACT

This paper studies the relationship among water conservancy investment, construction of water conservancy facilities and agricultural development through unit root test, co-integration test, Granger causality test and multivariate regression analysis. It demonstrates that there exist long-term co-integration relations between water conservancy investment and agricultural development, and between the construction of water conservancy facilities and agricultural development. It is proven that the investment is not the granger cause of the development but the construction is the Granger cause of the development. The result of regression analysis based on the agricultural growth mode suggests that increases in the effective irrigation area and soil erosion control area can notably promote agricultural development while water logging control area has no such an effect on agriculture.

KEYWORDS

Water conservancy investment; Construction of water conservancy facilities; Agricultural development.

INTRODUCTION

Many studies have shown that the construction of water conservancy facilities can promote economic development [1][2][3]. Investments in water conservancy constructions, in theory, are not only meant to solve the problems encountered in irrigation, flood prevention and power generation, but can also help reduce the degree of water shortage and production cost in agriculture, which is of great significance to agricultural development. Rosegrant and Ringler (2000) believe that transferring agricultural water to industrial use and urban consumption is detrimental to local agricultural development through analysis under the circumstance of fierce competition in water consumption[4]. Based on the equation of agricultural production, given more inputs, Cai, Ringler and You (2008) also came to the same conclusion by empirical analysis. However, this conclusion is only suitable for low value-added crops[5]. The study by Wu Lipin (2012) suggests that there exists a balanced relationship between water conservancy investment and agricultural development--the former is the Granger cause of the latter and has obvious positive hysteretic effect on the latter[6]. However, this paper comes to a conclusion different from that of Wu Lipin (2012), believing that the water conservancy investment is not the Granger cause of agricultural development. Considering that the medium and large projects are key to water conservancy investment in China, the paper makes a differentiation between water conservancy investment and the construction of water conservancy facilities. It also makes studies on their relations, as well as the efficiency of water conservancy investment in China.

Research method

Most unsteady time series data cannot meet the demands of the traditional multiple regression and other methods, which may result in “false regression”. However, the co-integration analysis can avoid such problems effectively. The chapter makes an investigation into the relations among variables first by unit root test and co-integration test. The related equation can be established only when there may be a long-term balanced relation among variables with same integration series or variables combination with different series based on judgments. On the basis of integration analysis, the Granger test will be made to judge the cause-and-effect relation among variables comprehensively and correctly. In the last part, the paper talks further about the relationship between the construction of water conservancy facilities and agricultural development with the multiple regression method.

Data specification

Taking the availability and characteristics of data into account, the paper chooses GPV (gross value for agriculture) and GDP1(GDP in primary industry) to measure agricultural growth[7]. WI (water investment) represents the investment in water conservancy and WB1(effective irrigation area), WB2 (flood control area) and WB3(soil erosion area) are related data to the construction of water conservancy facilities. These data are from China Statistical Yearbook and China Water Conservancy Yearbook from 1989-2011.

The study shows that Napierian logarithm processing will not change the integration corelation of original variables, but it will remove the heteroskedasticity in time series. Therefore, the paper processes GRV and WI with the Napierian logarithm and the results are noted as LNGRV and LNWI. Figure 1 shows their increases, from which the two series are judged to be imbalanced, thus needing differential treatment.

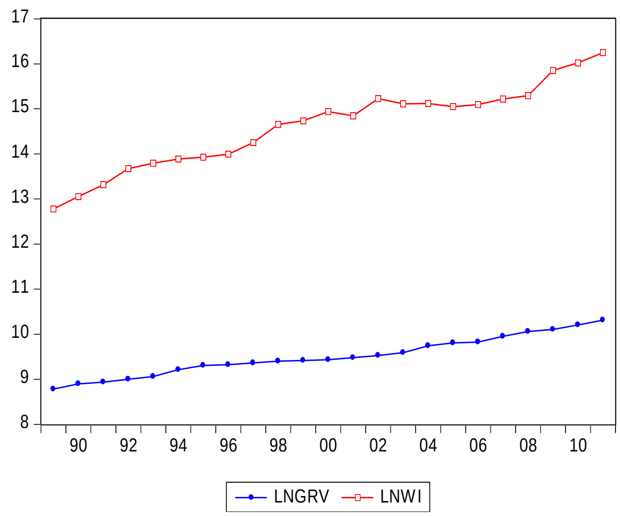

Figure 1 : The variation trend of LNGRV and LNWI

THE RELATIONSHIP BETWEEN WATER CONSERVANCY INVESTMENT AND AGRICULTURAL DEVELOPMENT

This part studies the relationship between water conservancy investment and agricultural development, based on the GRV measuring agricultural development and WI for investment.

Unit root test

TABLE 1 shows the results of unit root test on variables with ADF method. It means that the original time series and the first difference series are not steady at the significance level of 10%, but LNGRV series and LNWI series after second difference are steady at the significance levels of 5% and 1% respectively. Therefore, the two series are second integrated series.

TABLE 1 : Results of ADF tests

Variables	(C,T,L)	T-Statistic	1% Critical Value	5% Critical Value	10%Critical Value	Results
LNGRV	(1, 0, 4)	-1.1608	-3.8574	-3.0404	-2.6606	Unstable
DLNGRV	(1, 0, 3)	-2.1984	-3.8574	-3.0404	-2.6606	Unstable
D^2LNGRV	(1, 0, 3)	-3.5977	-3.8868	-3.0522	-2.6666	Stable
LNWI	(1, 0, 0)	-1.4728	-3.7696	-3.0049	-2.6422	Unstable
DLNWI	(1, 0, 1)	-1.8691	-3.8085	-3.0207	-2.6504	Unstable
D^2LNWI	(1, 0, 0)	-10.3138	-3.8085	-3.0207	-2.6504	Stable

(Note：Note: C, T, L represent respectively the constant items, the trend term and lag series number, D said first difference,D^2 said second difference.)

Integration test

The integration test was made with the Johnson test method. TABLE 4-2 shows the maximum Eigen value of the Johnson test and its results.

TABLE 2 : Results of Johansen test

Hypothesized No. of CE (s)	Eigen value	Trace Statistic	5%Critical Value	P value
No	0.4874	19.3042	20.2618	0.0673
At most 1	0.2219	5.2701	9.1645	0.2551

From the P value, the two series share an integrated relationship at the significance level of 10%, which means a long-term steady relationship between LNGRV and LNWI. The equation of its long-term balance is:

$$LNGRV = 0.5637 + 0.5796LMWI \quad \textbf{(1)}$$

(3.1008) (21.1385)

Equation (1) shows a positive correlation between water conservancy investment and agricultural development, with the elastic coefficient of 0.5796 in the sample period.

The Granger test

The integration test suggests a long-term balanced relationship between agricultural development and water conservancy investment by the government in the sample period, but this cause-and-effect relation still needs further confirmation.

The Granger cause-and-effect test shows that agricultural development is the Granger cause for water conservancy investment, but the latter is not the Granger cause of the former. That is to say, the increase in water conservancy investment will not promote agricultural development, but the development is conducive to the investment.

Therefore, the integrated relationship between the investment and the development is only demonstrated by the development’s impact on the investment. Although many studies show a positive effect of the investment on the agricultural development, the paper finds that water conservancy investment has no obvious positive effect on the development.

TABLE 3 : Results of Granger causality test

Null Hypothesis	Lags	F-Statistic	P value	Results
LNGRV does not Granger Cause LNWI	1	5.7098	0.0274	Reject
LNWI does not Granger Cause LNGRV		0.0416	0.8405	Accept
LNGRV does not Granger Cause LNWI	2	3.0072	0.0779	Reject
LNWI does not Granger Cause LNGRV		1.4177	0.2711	Accept
LNGRV does not Granger Cause LNWI	3	3.6189	0.0426	Reject
LNWI does not Granger Cause LNGRV		0.3560	0.7857	Accept
LNGRV does not Granger Cause LNWI	4	2.1948	0.1429	Accept
LNWI does not Granger Cause LNGRV		1.0797	0.4167	Accept

THE RELATIONSHIP BETWEEN THE CONSTRUCTION OF WATER CONSERVANCY FACILITIES AND AGRICULTURAL DEVELOPMENT

Empirical studies have proven that water conservancy investment has no obvious positive impact on agricultural development, but it does not mean that the development of water construction facilities, especially those in agriculture, are not conducive to agricultural development. This part will make a further study on the relationship between the construction of water conservancy facilities and agricultural development, with GDP1 to measure the development and WB1 for the construction of water conservancy facilities in agriculture. The two variables are processed first with logarithm and noted as LNGDP1 and $LNWB_{1.}$

Unit root test

TABLE 4 shows the results of unit root test on variables with ADF method, in which the original time series and the first difference series are not steady at the significance level of 10%, but LNWB1 and LNGDP1 after first difference are steady at the significance levels of 10% and 1% respectively. Therefore, the two series are first integrated series with a possible integrated relation.

TABLE 4 : Results of ADF tests

Variables	(C,T,L)	T-Statistic	1% Critical Value	5% Critical Value	10%Critical Value	Results
LNGDP1	(1， 0， 1)	-0.3931	-3.7880	-3.0124	-2.6461	Unstable
DLNGDP1	(1， 0， 0)	-2.7277	-3.7880	-3.0124	-2.6461	Stable
$LNWB_1$	(1， 0， 1)	1.2378	-3.7880	-3.0124	-2.6461	Unstable
$DLNLNWB_1$	(1， 0， 1)	-5.4021	-3.7880	-3.0124	-2.6461	Stable

Integration test

TABLE 5 shows the maximum Eigen value and the results of Johnson test.

TABLE 5 : Results of Johansen test

Hypothesized No. of CE (s)	Eigen value	Trace Statistic	5%Critical Value	P value
No	0.5524	17.4976	15.4947	0.0246
At most 1	0.0289	0.6168	3.8415	0.4322

From the P value, there exists an integrated relation between two series at the significance level of 5%, which means a long-term relationship between LNGDP1 and LNWB1. Its corresponding equation on long-term balance is:

$$LNGDP1 = -33.1579 + 7.9045 LNWB_1 \tag{2}$$

(-16.1502) (18.1857)

Equation (2) shows a positive correlation between the construction of water conservancy facilities and agricultural development, with the elastic coefficient of 7.9045 in sample period.

Granger test

The Granger test shows a long-term balance between effective irrigation area and agricultural development in the sample period, but the cause-and-effect relation still needs further confirmation. The following part will make an investigation into the possible cause-and-effect relation between $LNWB_1$ and LNGDP1 based on the first differentiation of the two variables.

The Granger test finds that, in the lag phases 2, 3 and 4, the development of water conservancy is the Granger cause of agricultural development, but the latter is not the Granger cause of the former. Therefore, water conservancy development in China can promote agricultural development, based on the Granger test.

TABLE 6 : Results of Granger causality test

Null Hypothesis	Lags	F-Statistic	P value	Results
$\Delta LNGDP_1$ does not Granger Cause $\Delta LNWB_1$	1	1.1700	0.2937	Accept
$\Delta LNWB_1$ does not Granger Cause $\Delta LNGDP_1$		1.9399	0.1806	Accept
$\Delta LNGDP_1$ does not Granger Cause $\Delta LNWB_1$	2	0.4322	0.6569	Accept
$\Delta LNWB_1$ does not Granger Cause $\Delta LNGDP_1$		6.8891	0.0075	Reject
$\Delta LNGDP_1$ does not Granger Cause $\Delta LNWB_1$	3	0.4534	0.7197	Accept
$\Delta LNWB_1$ does not Granger Cause $\Delta LNGDP_1$		7.5683	0.0042	Reject
$\Delta LNGDP_1$ does not Granger Cause $\Delta LNWB_1$	4	0.5866	0.6806	Accept
$\Delta LNWB_1$ does not Granger Cause $\Delta LNGDP_1$		8.3250	0.0043	Reject

FURTHER STUDY ON THE IMPACT OF THE CONSTRUCTION OF WATER CONSERVANCY FACILITIES AND AGRICULTURAL DEVELOPMENT

The studies above indicate that investment in water conservancy has no much positive effect on agricultural development, but construction of water conservancy facilities can promote agricultural development. The reasons may rest on the hysteresis effect of water conservancy investment on one hand, and the limited direct investment in small and medium-sized agricultural water projects on the other hand. The following part will make a further study on the impact of the construction of water conservancy facilities on agricultural development by regression analysis.

Based on the traditional paradigm of economics researches, it can be noted as:

$$Y = TECH \times CAPITAL^{\beta_1} \times LABOR^{\beta_2} \times LAND^{\beta_3} \times WB_1^{\beta 4} \times WB_2^{\beta 5} \times WB_3^{\beta 6} \tag{3}$$

in which Y means GDP1; TECH is total power of agricultural machinery; CAPITAL is the total fixed assets by multiplying productive fixed asset of in rural area with the number of rural residents; LABOR is the employees in primary industry; LAND is the total area for crops; WB1, WB2 and WB3 are effective irrigation area, flood control area and soil erosion control area respectively; β_1, β_2, β_3, β_4, β_5, β_6 are elastic coefficients of the variables.

To avoid the influences by heteroskedasticity and data, Equation 3 was processed with Napierian logarithm as:

$$LNY = LNTECH + \beta_1 LNCAPITAL + \beta_2 LNLABOR + \beta_3 LNLAND + \beta_4 LNWB_1 + \beta_5 LNWB_2 + \beta_6 LNWB_3 \tag{4}$$

To tackle the relations among variables more meticulously, Equation 4 was deduced in variables' amount and Equation 5 and Equation 6 were adjusted as:

$$LNY = LNTECH + \beta_1 LNCAPITAL + \beta_2 LNLABOR + \beta_3 LNLAND + \beta_4 LNWB1 \tag{5}$$

$$LNY = LNTECH + \beta_1 LNCAPITAL + \beta_2 LNLABOR + \beta_3 LNLAND \tag{6}$$

TABLE 7 : Estimate results of Equations

Variables	Equation 6	Equation 5	Equation 4
C	5.8996	3.0277	28.2682***
LNCAPITAL	0.6881***	0.1464	0.0432
LNLAND	0.0578	-2.4828**	1.2628
LNLABOR	-1.0523***	-0.9253***	-0.2670
LNWB1	—	3.6892***	2.2815***
LNWB2	—	—	-12.2630***
LNWB3	—	—	2.5128***
R^2	0.9765	0.9879	0.9938

TABLE 7 shows the estimated results of equation (4) - (6), which proves that capital investment has a positive effect on economic development in rural area, although the effect is not obvious in equation (4) and (5); the size of total area of crops has no effect on agricultural development due to the even negative value in equation (5); and labor investment is negative to economic development in rural area, which means the economy in rural area is not accelerated by labor increase. From the index of the construction of water conservancy facilities,, increases in effective irrigation area and soil erosion control area can notably promote the economy in rural area, while changes in flood control area play a negative role which means there's no obvious increase in flood control in the sample period.

CONCLUSION

It seems to be contradictory among the results of empirical tests, but detailed analysis of the results has proven the plight in China's water conservancy investment. Based on the results, the paper comes to conclusions:

There exists a long-term integrated relationship between the investment in water conservancy and economic development in rural area. However, the Granger test shows that the investment increase is not conducive to agricultural development while the latter can benefit to the former on the contrary.

There exists a long-term integrated relationship between the construction of water conservancy facilities and economic development in rural area. Based on the results of Granger test, the development of water conservancy facilities can promote the economic development in rural area.

Increases in effective irrigation area and soil erosion control area can be notably beneficial to the economic development in rural area, but the increase in flood control area has no such an effect.

The large-scale investment in water conservancy of China has not been efficient to the improvement of water conservancy construction in rural area, small and medium-sized construction projects in particular. Further studies are still needed to prove whether the fund investment in water conservancy is used for building hydropower stations.

ACKNOWLEDGMENT

This research was supported by the National Soft Science Project (2013GXS2D033), the Planned Science and Technology Project of Hunan Province of China (2012NK3112）, and Preliminary research project of National Social Science Fund of CSUFT（2011YY001）.

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[7] The two variables in time series are different. We choose them to reflect agricultural development is helpful for empirical study without affecting the conclusion.