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Green Food Industry and Quality of Economic Growth in China: The Positive Analysis Based on Granger Causality Test and Variance Decomposition

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Abstract: In order to test the impacts of the green industry transformation on the economic development, the article analyzes the relationship between the green food industry development and quality of economic growth, based on the Granger causality test and variance decomposition, using the data from 1996 to 2010 in China. The results show that: in the long run, the relationships between domestic sales, exports and real outputs of the green food industry and the quality of economic growth are stably positive correlation. In the causal relationship term, the relationship between domestic sales, exports and the quality of economic growth shows a positive one-way causal relationship; the relationship between real outputs and the quality of economic growth shows a slight two-way causal relationship. Through variance decomposition analyzing, the results suggest that the promotion effects of domestic sales, exports and real outputs of the green food industry on the quality of economic growth exist a certain differences. In the end, the results are deeply analyzed and discussed.

Keywords: Green food industry, granger causality test, quality of economic growth, variance decomposition

INTRODUCTION AND LITERATURE REVIEWS

Since the early 1990s, China officially puts forward the development of green food as people's consumption consciousness and market expanded gradually. The green food industry under such multiple drives as are the rapid economic development, policy support, market demand and market interest stimulation and food safety, environmental protection and green barriers in international trade has expanded gradually. Green food industry promotes conventional and intensive agriculture with high cost, high pollution and high dependence on non-renewable resource consumption to relying more on innovation of science and technology, informatization and standardization production. As we all know, it is the modern green agriculture relieving the adverse effects of conventional agriculture on industries and the economic development, which maintains the basic eco-capital stocks and realizes a win-win between economic and ecological benefits (Yan *et al*., 2009). Thus, through studying the relationships between green food industry and the quality of economic growth, in an attempt to seek a way which can promote the healthy and coordinated development of green food industry, there is no doubt that this can promote the sustained, healthy, harmonious and stable development of national economy in China.

Throughout the existing research we can understand roughly, green food industry, as it ensures food safety (Yao, 1998), maintains the non-reduction of eco-capital stocks (Yan *et al*., 2009), speeds up the transition of economic development (Liu *et al*., 2004), enhances the international competitiveness of agricultural products and optimizes the structure of agricultural production (Wang *et al*., 2007, 2009a), has a positively stimulative effects on the improvement of the quality of economic growth. Therefore, to achieve economically sustainable development, it is a mutual adaptation and interaction of maintaining the ecological sustainability and economic sustainability in essence (Liu, 1997). It should be pointed out that the current research methods and perspectives mainly focus on the theoretical descriptions of policy and countermeasure (Yao, 1998; Mei *et al*., 1999; Jin, 2000; Li, 2001; Fang, 2003, etc.), however, empirical research is rare (Wang *et al*., 2007, 2009a; Song and Liu, 2008) and even more less within the study of the relationships between green food industry and quality of economic growth. The relationships between green food industry and quality of economic growth are very complex, especially making a very precise quantitative estimation of the mutual improvement between green food industry and the quality economic growth.

In order to test the impacts of the green industry transformation on the economic development, with more clearly describing the relationships between green

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food industry and the quality of economic growth in China, this study uses data from 1996 to 2010 and employs the dynamic econometric analysis of co-integration theory and Granger causality test to study the relationships between green food industry and the quality of economic growth in China based on the results of existing researches and then we adopt variance decomposition to depict the magnitude of the relationships between green food industry and the quality of economic growth. With this understanding, we look forward to providing empirical grounds for the coordinated development between green food industry and the quality of economic growth in China.

THE ANALYSES

Model estimation technique: This research makes a comprehensive study of the mass effects of economic growth on green food industry. The domestic sales, exports and real outputs of green food measures the level of green food industry and the econometric model, is used to measure the impacts of green food industry on the quality of economic growth. Our general model is as:

$$Y_t = \beta_0 + \beta_t X_t + \mu_t \quad (1)$$

Subscript t represents the time period and Y_t is the dependent variable for the quality of economic growth at each time period. X_t is the level of green food industry. The term β_0 and β_t represents the constant and the vector of coefficients for predictor variables respectively that includes domestic sales, exports and real outputs of green food and vary over time, u_t is the disturbance term.

Variables and data sets:

The quality of economic growth: With kinds of measures for the index of the economic growth, many scholars use GDP (Wang *et al*., 2009b) to reflect the economic growth, which it reflects in the rate of economic growth. However, we are concerned with the relationships between the emerging green industry and economic growth. Thus, the author posits that GDP per CO_2 represents the quality of economic growth (QGDP), which is much more reasonable. For eliminating the influence of inflation, GDP are calculated by dividing the total GDP measured in constant 1990￥ by the total carbon dioxide emissions(i.e. billion Yuan/tons of standard coal).

Levels of green food industry: Researches on the level of green food industry are not much. According to the methods of Yao (1998), Wang *et al*. (2007), Zhao *et al*. (2006), Song and Liu (2008) and Han (2010), this study select domestic sales (NXSE), exports (NCKE) and real outputs (SWZL)of green food industry to measure the magnitude of the development of green food industry, as eliminates the influence of price changes.

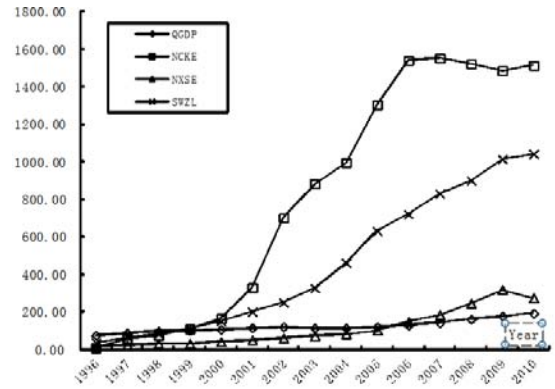

Fig. 1: Trends of green food industry and quality of economic Growth from 1996 ~ 2010

Given that the green food industry is a new pattern and system of agriculture with a short history, there are very few indicators and data used for the horizontal and vertical contrast (Han, 2010), under considering the availability of data. We set the sample interval from 1996 to 2010 and analyze empirically the relationships between green food industry and the quality of economic growth. The raw data on the related indexes of the level of green food industry are derived from the "statistical yearbook of green food in China" (1997～2010), then GDP and CO_2 emissions[1] are from "Statistical Yearbook in China" (2011).

As Fig. 1 reflects the trends of green food industry and the quality of economic growth from 1996～2010, we can find that the change of green food industry is mainly consistent with the trends of the quality of economic growth. Therefore, there is a synergetic effect between green food industry and the quality of economic growth. This study was analyzed with E Views 6.0.

RESULTS

Unit root test: In order to avoid the spurious regression of the non-stationary time series data, we conduct a unit root test of the variables before the Co-integration Analysis with E Views 6.0 and determine its stability. Due to time series variables only under the I (d) conditions, there can be a co-integration analysis. The results suggest that the level value of QGDP, NXSE, NCKE, SWZL and their first-order difference are all non-stationary variables, but their second order difference are stationary under the significance level of 1% and integrated (Table 1).

Co-integration test: The results of ADF unit root test shows that the time series variables are second order

Table 1: Results of ADF unit root test

Variable	ADF test Test form	Statistics of ADF test	Threshold	Prob.	Y/N
QGDP	(C,T,3)	-2.0237	-3.4200*	0.5265	*N*
D(QGDP, 1)	(000)	-0.8263	-1.6037*	0.3385	*N*
D(QGDP, 2)	(000)	-2.9838	-2.7719***	0.0064	Y
NXSE	(C00)	0.3623	-2.6904*	0.9727	*N*
D(NXSE, 1)	(CT1)	-2.4886	-3.3630*	0.3269	*N*
D(NXSE, 2)	(001)	-2.8377	-2.7922***	0.0091	Y
NCKE	(CT1)	-2.2564	-3.3630*	0.4251	*N*
D(NCKE, 1)	(000)	-1.3675	-1.6037*	0.1511	*N*
D(NCKE, 2)	(001)	-3.8592	-2.7922**	0.0012	Y
SWZL	(CT0)	-2.1279	-3.3423*	0.4882	*N*
D(SWZL, 1)	(000)	-0.8701	-1.6037*	0.3200	*N*
D(SWZL, 2)	(000)	-4.2485	-2.7719***	0.0005	Y

C, T, L represents intercept, time trend and lag period respectively. X, D (X, 1), D (X, 2) are for the level value of variable X, first-order difference and two order difference. *: p<0.1, **: p<0.05, ***: p<0.01. N-non-stationary, Y-stationary

Table 2: ADF test for co-integrating relationship between *QGDP* and *NXSE, NCKE, SWZL*

Variable	StatisticsofADF test	Threshold	Lag period	Conclusion
$\hat{\mu}_{1t}$	-2.6025	-1.9684**	0	*Y*
$\hat{\mu}_{2t}$	-3.4967	-2.7550***	1	*Y*
$\hat{\mu}_{3t}$	-2.4247	-1.9710**	1	*Y*

*, **, ***: The thresholds under the significance levels of 10%, 5% and 1% respectively; Y-stationary

integration. Therefore, they can be used to test the co-integration relationship between green food industry and the quality of economic growth. Due to the variables is second order integration, JJ test no longer applied. In view of this, we employ E-G two-step to test the co-integration relationships between *QGDP* and domestic sales (*NXSE*), *QGDP* and exports (*NCKE*), *QGDP* and real outputs (*SWZL*) of green food industry, respectively.

The first step: co-integration regression. We employ OLS to make the static regression analysis for *QGDP* and *NXSE, NCKE* and *SWZL*, respectively and calculate the residual error of regression equation:

$$QGDP = \underset{(22.850)}{0.8825} + \underset{(11.916)}{0.0003}\ NXSE + \hat{\mu}_{1t} \quad (2)$$

$$QGDP = \underset{(11.012)}{0.8876} + \underset{(5.347)}{0.0042}\ NCKE + \hat{\mu}_{2t} \quad (3)$$

$$QGDP = \underset{(16.545)}{0.8583} + \underset{(9.129)}{0.000082}\ SWZL + \hat{\mu}_{3t} \quad (4)$$

The second step: ADF test for stationarity of the residual sequence. The results of three residual sequence show that, when the lag order were 0 and 1, the model without the intercept and time trend is an optimal mode. Then we can get the results of co-integration test (Table 2).

Table 2 shows that the test statistics of ADF for the residuals $\hat{\mu}_{1t}$, $\hat{\mu}_{2t}$ and $\hat{\mu}_{3t}$ of three regression equations are less than the thresholds of 5, 1 and 5%, respectively in the sample interval from 1996 to 2010. Namely, there are stationary for the residual series as well as existing a certain stationary linear combinations between *QGDP* and *NXSE*, *NCKE* and *SWZL* respectively. Through co-integration test on *QGDP* and *NXSE*, *QGDP* and *NCKE, QGDP* and *SWZL* two by two, we find that there exists co-integration relationships between them. Thus, there is a long-term stable equilibrium relationship between green food industry and the quality of economic growth and is co-integration.

Granger causality test: Co-integration test can reveal whether the long-term stable equilibrium relationships exist between the variables, however, it cannot reveal the direction of the relationships among variables. And also, for the quality of economic growth (QGDP) and the level of green food industry *(NXSE*, *NCKE* and *SWZL*), it cannot point out that which is the reason and which is the result or reciprocal causation?

Table 3 shows the results of Granger causality test based on the optimal lag period of VAR model. First, we can see from Table 3 that there exists a unidirectional Granger causality between *QGDP* and *NXSE*, due to the probability of *NXSE* does not Granger Cause *QGDP* is 0.0024, less than 0.01, but it receives the null hypothesis of *QGDP* does not Granger Cause *NXSE*. Secondly, the analysis of Granger causality between the quality of economic growth and green food exports (*NCKE*), real output (*SWZL*) in Table 3 shows, in the lag period 2 and in the confidence level of 1 and 10%, respectively, that green food exports (*NXSE*) is the significant factor of the quality of economic growth, but the quality of economic growth (*QGDP*) does not Granger Cause green food exports (*NXSE*). There is a two-way causal relationship between *QGDP* and *SWZL*, but the causal relationship is relatively weak. That is to say, an increase in real outputs can improve the quality of economic growth, at the same time the quality of economic growth will also bring the expansion of real outputs in demand and promote the development of green food industry.

Variance decomposition: Variance Decomposition estimates the relative significance of the shock of each variable in VAR model contributes to the Dynamic of system variables, which the main perspective is that it decomposes Mean Square Error (MSE) into the error deriving from its own shock and the error stemming from the shock to the other variables in order to study the relative significance of each variable shocks to endogenous variables in model. To estimate quantity relationship among variables, we decompose forecast-Error Variance of the quality of economic growth (*QGDP*), domestic sales (*NXSE*), exports (*NCKE*) and real outputs (*SWZL*) of green food industry by the method of Variance Decomposition. Limited by the article space, we only give the results of variance decomposition of quality of economic growth. (Table 4)

Table 3: Results of Granger causality test

Variable	Null Hypothesis H_0	The optimal lag	F-statistic	Prob.
NXSE	NXSE does not Granger Cause QGDP	1	15.3944	0.0024
	QGDP does not Granger Cause NXSE	1	0.0943	0.7645
NCKE	NCKE does not Granger Cause QGDP	2	9.8284	0.0070
	QGDP does not Granger Cause NCKE	2	0.6625	0.5417
SWZL	SWZL does not Granger Cause QGDP	2	3.9726	0.0634
	QGDP does not Granger Cause SWZL	2	3.7660	0.0704

Table 4: Variance decomposition of quality of economic growth

Period	S.E.	QGDP	NXSE	NCKE	SWZL
1	0.0291	100.0000	0.0000	0.0000	0.0000
2	0.0408	58.7012	22.6058	12.1540	6.5390
3	0.0627	24.9903	48.2108	24.0246	2.7743
4	0.0930	57.1181	28.3601	13.2339	1.2879
5	0.2332	23.1607	68.3591	6.4728 0	2.0074
6	0.2900	35.5500	56.5619	6.5845 0	1.3035
7	0.5472	23.8764	71.0592	3.7115 0	1.3530
8	0.6691	39.2068	47.6285	11.0256	2.1391
9	1.3307	14.2984	77.6437	5.1292 0	2.9288
10	1.7908	43.2675	46.2713	8.3029 0	2.1583

As illustrated by the Table 4, right after a shock, the contribution of quality of economic growth shocks to its own appears to be large, while getting smaller in later period, which generally shows a trend of fluctuations; the contribution of a shock of the domestic sales (NXSE) to the quality of economic growth begins to emerge in period 2, increases from 22.61% in period 2 to 77.64% in period 9, which indicates a upward tendency despite of some fluctuation; the contribution of exports and real outputs of green food to the quality of economic growth does not appear until period 2 and drops after a gradual increase with a certain fluctuation. In general, the contribution of exports (NCKE) of green food keeps stably around 10%, while the contribution of real outputs (SWZL) of green food is relatively weaker, a converge to about 2%.

DISCUSSION AND CONCLUSION

The article is based on the time series data of China from 1996 to 2010, using co-integration test, granger causality test and variance decomposition model to dynamically analyze the relationships between the quality of economic growth and green food industry. The main conclusions are as follows:

- At the unit root test point , the quality index of economic growth, the domestic sales (*NXSE*), exports (*NCKE*) and real outputs (*SWZL*) variables are integrated of second order (i.e., I (2)). Therefore, if we directly use time series data to test, it will tend to have a spurious regression
- At the co-integration test point, there is a long-term stable equilibrium relationship between the quality of economic growth and green food industry. In the long term, the development of green food industry has a long-term effect on enhancing the quality of economic growth;
- At the Granger causality test point, the development of green food industry has a strong explaining power on enhancing the quality of economic growth, which indicates that the rapid development of green food industry has obviously positive effects on improving the quality of economic growth
- The variance decomposition results show that the growth of the domestic sales (*NXSE*) and exports (*NCKE*) of green food industry have a more long term positive effect on enhancing the quality of economic growth, but the real outputs (*SWZL*) affected by the sample size and time lag factor has a negative impact on the improvement of the quality of economic growth. With the restructuring of agricultural production, the strategic transformation of agriculture and the unceasingly expansion of green food industry scale and other factors, the negative effects gradually decline and converge to zero

In the long term, the positive effect of the development of green food industry on the quality of economic growth will gradually increase along with the implementation of economic transformation and sustainable development strategy in China. It should be clear that the green food industry is an emerging industry, history of development is relatively short and scale is small relatively to other industries as well as the domestic market demand is weak, international market development is insufficient and economic efficiency is low, which result in the green food industry lacking of power and failing to form the internal economic strength required for development of green food industry. This results in the output value of green food industry having a small share in the national economy. For the contribution rate to the quality of economic growth alone, it is very low. Especially, the real outputs of green food industry is infinitesimally small in the traditional agricultural development stage when the level of economic development is low because it is affected by the structural adjustment of agricultural production, perception and consumption level of the target consumers, which cannot reflect the higher quality and the higher price, results in the decline of agricultural and social total outputs and thus inhibits the improvement of the quality of economic growth.

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End note:

1 CO_2 emissions are calculated according to the Kaya carbon identity. Coefficients of CO_2 emissions of different energy according to the weighted mean value with the coefficients of CO_2 emissions of Japan Institute of energy economics, DOE/EIA, the climate change project in State Scientific and Technological Commission and Energy Research Institute of National Development and Reform Commission, are seen as an estimation basis of CO_2 emissions in China.