Analysis on the Influence of Agricultural Economic Development on Agricultural Non-Point Source Pollution in China

Wanqing Sang[1] and Qiyuan Sang[2*]

[1]College of Economics, Sichuan Agricultural University

[2]Sichuan University, Chengdu, China

E-mail: qiyuan@scu.edu.cn

[*]Corresponding author

Keywords: Agricultural Non-Point Source Pollution; Agricultural Economic; Econometrics

Abstract: Mode of sustainable development, agricultural non-point source pollution has become the factors that affect the agricultural economy development of our country should not be neglected, from the current view, bearing capacity of the rural ecological environment has been close to the limit, a tighter resource constraints have led to the original "high investment, high output" unsustainable development mode, the contradiction between economic development and ecological environment protection agriculture also more and more prominent. Thus, this article attempts from the Angle of economics to explore, the relationship between economic growth and agricultural ecological environment pollution by determining related parameters of agricultural non-point source pollution and the economic growth is closely related to the agricultural non-point source pollution index, build VAR and VEC model, find out main influencing factor of the economic development in the agricultural non-point source pollution, inner drive mechanism in the evolution of the agricultural non-point source pollution, so as to the management of agricultural ecological environment and agricultural economic growth and ecological environment protection coordination development.

1. Introduction

Agriculture as the foundation of the industry in China, has always been the focus of national attention and development. Since the reform and opening-up, with the development of modern agriculture and promote large-scale animal husbandry, although the rapid growth of agricultural economy and steady increase in farmers' incomes, stable for two consecutive years in more than 1.2 trillion jins, but in constant overdraft at the expense of ecological resources, in order to "high investment, high in energy intensive and waste" as the main line of the agricultural development pattern formed a large number of agricultural ecological environment debt, and make agriculture is currently facing a variety of environmental problems and ecological crisis, limited resource utilization of string tension more and more tightly. As a whole,the marginal benefit of China's agricultural inputs has declined significantly, the carrying capacity of the rural ecological environment has approached its limit, and resource constraints have made the original development model of "high input and high output" unsustainable. The contradiction between agricultural economic development and ecological environmental protection has become more and more prominent.

Agricultural ecological environment is mainly under the dual pressure of exogenous pollution and endogenous pollution, but endogenous pollution, that is, non-point source pollution of agriculture, has become the primary bottleneck restricting the healthy development of agriculture, and also the main culprit causing water pollution and lake eutrophication in China.From the relevant statistics, since the reform and opening-up, our country find up nearly 4.5 times, China's grain output rose by only 82.8% over the same, find growth is far more than food production growth, much higher than the world average increment, but its utilization is very low, China's three

DOI: 10.38007/Proceedings.0000056 ISBN: 978-1-80052-000-4

major food crops of nitrogen fertilizer, phosphate fertilizer, potash fertilizer utilization rate is only 33%, 24% and 42%, agricultural inputs into marginal benefit is low. In addition, the lack of supervision on agricultural non-point source pollution, livestock and poultry manure, pesticide residues and other disorderly discharge, resulting in a series of agricultural environmental problems. In 2015, the no. 1 document of the central government made important arrangements for the control of agricultural ecological environment. The control of non-point source pollution in agriculture has become a crucial task for promoting agricultural modernization and realizing sustainable agricultural development. In addition, relevant agricultural experts pointed out that under the new normal of economy, the internal environment of China's agriculture has undergone profound changes, and agricultural development should attach importance to coordinated development instead of blindly pursuing large-scale continuous growth.

But it also brings us a question worth thinking, whether the growth of agricultural economy brought by the application of modern agricultural technology will inevitably lead to the increase of agricultural pollution and the deterioration of rural ecological environment, and what is the interaction between agricultural economic development and agricultural non-point source pollution? Can agricultural economic growth and ecological environmental protection be coordinated? The research on this aspect is represented by the Environmental Kuznets Curve (EKC) proposed by researchers in the 1990s, which shows that there is a long-term close relationship between economic growth and environmental pollution, and presents an inverted U shape. With the increasingly serious agricultural environmental problems, domestic and foreign researchers have been paying more and more attention to the relationship between agricultural environmental pollution and economic growth, trying to explore from various perspectives, but focusing more on the verification of the existence of agricultural non-point source pollution EKC and the prediction of future development trend in a specific region. However, the bidirectional influence mechanism and dynamic correlation effect between agricultural economic development and ecological environment are ignored, which easily leads to variable endogenous bias. Based on this, this paper, by using the data from 1985 ~ 2015 in our country, the use of econometric model on the basis of the VAR and VEC, try to explore from the perspective of economics, economic growth and the relationship between the agricultural ecological environment pollution, the analysis of agricultural non-point source pollution in the response to hit from other, find out the main influencing factor of the economic development in the agricultural non-point source pollution, inner drive mechanism in the evolution of the agricultural non-point source pollution, so as to the management of agricultural ecological environment and agricultural economic growth and ecological environment protection coordination development to provide theoretical reference.

2. Empirical Study on the Impact of Agricultural Economic Growth on Agricultural Non-point source Pollution

From the traditional econometric analysis method, mostly on the basis of economic theory to establish the model of the relation between variables but economic development is affected by many aspects, economic theory to the dynamic relationship between variables usually isn't enough to provide a rigorous, but are not sure the endogenous variables appear in the left side of the equation or the right end, makes the model estimation and inference becomes more complicated. So this article chooses a non-structural method to establish the agricultural economic growth and the relationship between the different variables of the agricultural non-point source pollution model, namely the system of each endogenous variable as the lag value of the system in all the endogenous variables of the function to construct the model, and the single variable regression model to multivariate time series of variable vector autoregressive model, to explore the agricultural economic growth of various economic impact on the effect of agricultural non-point source pollution.

2.1 Agricultural non-point source pollution index selection and data calculation

Agricultural non-point source pollution can also be referred to as non-point source pollution, which involves a large range and a wide distribution area. Agricultural non-point source pollution in China mainly includes the following four categories: first, fertilizer pollution. In the process of transition from traditional agriculture to modern agriculture, agricultural economic growth mainly depends on the input of chemicals, which was once called the "accelerator" of agricultural economic growth. According to statistics, the amount of fertilizer in China accounts for more than one third of the world, per mu of fertilizer application 21.9 kg, far higher than the world average level of 8 kg per mu, but the actual utilization rate is less than 40 percent. In addition, the application structure is unreasonable, which intensifies the eutrophication trend of surface water. Second, livestock and poultry pollution. Mass breeding in recent years the development of strength increasing, but the resulting environmental problems are increasingly prominent, such as farms of untreated sewage directly discharged to the nearby water bodies, untreated manure directly exposed to the air, which caused great pollution to the surrounding environment, according to statistics, China's livestock waste production amount is 4 times the left and right sides of the industrial solid waste emissions; Third, farmland solid waste pollution. This mainly refers to the pollution of crop straw. China produces about 700 million tons of crop straw every year, ranking the first in the world. As a valuable renewable material resource, most of the crop straw in China has not been treated with any treatment. Fourth, pollution of rural life. China's rural population is large and dispersed, and the pollution caused by the loss of rural sewage and feces is not to be underestimated.

From the above analysis of agricultural non-point source pollution, combined with the specific situation in China, the main pollutants of agricultural non-point source pollution are COD, total nitrogen and total phosphorus emissions, which are also the main sources of water eutrophication. Y is the emission of agricultural non-point source pollution. The inventory analysis method of existing researchers is used to calculate agricultural non-point source pollution. The data mainly come from agricultural statistical data such as China statistical yearbook, China agricultural statistical yearbook and China environmental bulletin over the years.

2.2 Variable description

Agricultural non-point source pollution is set as variable Y, agricultural economic scale is set as variable X1, and is the total agricultural output value over the years; The size of agricultural population was set as variable X2, expressed by the number of rural population. The proportion of livestock and poultry breeding industry is set as variable X3;The proportion of grain and crop is set as variable X4;Agricultural technology progress rate was set as variable X5, and the data source was based on the results of previous studies. Agriculture set as variable X6 opening to the outside effect, give full consideration to the agricultural "go out" and "introduction to" two aspects, the agricultural product import and export of agricultural products, agricultural international capital flow as the important indexes of agricultural openness, according to the research of scholars research and to set the target weights of the three, determine formula for agricultural openness: Agricultural openness to the outside world=0.2 * the added value of agricultural imports/agriculture 0.7 *Agricultural imports/agricultural added value+ 0.1 * / added value of agriculture.

3. Model Construction and Empirical Analysis

3.1 Construction of empirical analysis model

Vector autoregressive model can be used to predict the associated economic time series system, and analyze the random disturbance of the variable system dynamic impact, and to further explain the economic impact of the impact of economic variables, this paper USES VAR model to our country agricultural non-point source pollution and economic growth on the empirical analysis of every index lag order for P VAR model expression is as follows: $y_t = \Gamma_1 y_{t-1} + \cdots + \Gamma_p y_{t-p} + Tx_t + \varepsilon_t$, the one ε_t is without the interference of autocorrelation vectors, and the same period with zero mean and covariance matrix $E[\varepsilon_t \varepsilon_t'] = \Omega$, y_t for k Dendogenous variable, x_t as D as exogenous variables, $\Gamma_1 \ldots \Gamma_p$ is the coefficient matrix $k \times k$ to be estimated, T is the coefficient matrix $K \times D$ to be estimated, and P is the lag order of the model.

3.2 Model estimation and result analysis

An implicit condition of VAR model is that all variables are stationary. If the variables are stationary time series, the unconstrained VAR model can be directly constructed. If it is not stationary, it needs to carry out the co-integration test, because the linear combination between two or more non-stationary variables may be stationary. If such a group of non-stationary linear combination exists, these variables are considered to have a co-integration relationship, that is, there is a long-term equilibrium relationship. Therefore, the unit root test is conducted for each variable to determine whether the time series variables are stationary vectors.

In order to eliminate possible variance and skewness, avoid spurious regression, of each variable in turn take logarithm, then carries on the stationarity test, in order to determine whether the variables vector, using Eviews8.0 unit root test, according to the results of the software operating lny, lnx1, lnx2, lnx4, lnx6 for non-stationary vector, lnx3, smooth lnx5 as vectors, and then for each variable differential treatment, results show that the variables presented first-order single whole (see table 1).

Table 1 Unit root test

The sequence	ADF value	5% significance level	10% significance level	Conclusion
lny_t	-4.942863	-2.986225	-2.632604	Significant
$lnx1_t$	-1.578488	-2.967767	-2.622989	No significant
$lnx2_t$	-2.910746	-3.568379	-3.218382	No significant
$lnx3_t$	-2.971079	-2.963972	-2.621007	Significant
$lnx4_t$	-1.297182	-3.568379	-3.218382	No significant
$lnx5_t$	-3.100522	-2.963972	-2.621007	Significant
$lnx6_t$	-2.170095	-3.568379	-3.218382	No significant
$\Delta lnx1_t$	-3.054504	-2.967767	-2.622989	Significant
$\Delta lnx2_t$	-2.359408	-3.574244	-3.221728	Significant
$\Delta lnx4_t$	-4.786435	-2.967767	-2.622989	Significant
$\Delta lnx6_t$	-5.985158	-2.967767	-2.622989	Significant

Based on this, the VAR model was established, and the lag length of the VAR model to be estimated was analyzed using the lag length standard, and the lag order of the model was determined according to the AIC and SC minimum principles, as shown in the following table. Considering the length of variable data, the lag order of the VAR model was selected as order 2, which was ideal.

Table 2 VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	268.9870	NA	1.76 e-17	-18.71336	-18.38031	-18.61154
1	400.5852	187.9974 *	5.41 e-20 *	-24.61323	-21.94882 *	-23.79869 *
2	455.3310	50.83542	7.67 e-20	-25.02364 *	-20.02788	-23.49639

* indicating lag order selected by the criterion

Then, the parameters of the VAR model are estimated. According to the output results of the software, the VAR model is as follows:

$$
\begin{Bmatrix} lny \\ \Delta lnx1 \\ \Delta lnx2 \\ lnx3 \\ \Delta lnx4 \\ lnx5 \\ \Delta lnx6 \end{Bmatrix} + \begin{Bmatrix} 0.178 \\ 0.124 \\ 0.099 \\ -1.696 \\ -0.677 \\ -1.958 \\ 7.922 \end{Bmatrix} +
$$

$$
\begin{Bmatrix}
0.846 & 0.204 & 6.189 & -0.496 & -0.167 & -0.219 & -0.024 \\
0.057 & 0.561 & -2.646 & -0.386 & 0.655 & 0.309 & 0.107 \\
0.006 & 0.015 & 0.364 & 0.099 & 0.024 & -0.0002 & 0.003 \\
0.133 & 0.254 & -4.778 & 0.034 & 0.056 & -0.001 & -0.026 \\
-0.253 & -0.081 & -4.005 & 0.287 & 0.055 & 0.022 & 0.152 \\
0.013 & 0.631 & -6.858 & -0.085 & 0.013 & 0.388 & 0.188 \\
0.573 & 0.472 & -6.196 & 7.922 & 0.234 & 0.021 & -0.848
\end{Bmatrix}
\begin{Bmatrix} lny \\ \Delta lnx1 \\ \Delta lnx2 \\ lnx3 \\ \Delta lnx4 \\ lnx5 \\ \Delta lnx6 \end{Bmatrix}_{t-1} +
$$

$$
\begin{Bmatrix}
0.129 & -0.174 & -0.110 & 0.589 & 0.085 & 0.168 & 0.057 \\
-0.049 & -0.543 & 6.074 & 0.456 & -0.025 & -0.316 & -0.019 \\
-0.02 & -0.025 & 0.265 & -0.013 & -0.014 & -0.003 & -0.006 \\
-0.031 & -0.38 & 1.849 & 0.161 & 0.285 & -0.122 & 0.034 \\
0.365 & 0.239 & 6.883 & -0.291 & 0.237 & 0.103 & 0.209 \\
0.006 & 0.185 & -4.875 & -0.084 & -0.109 & 0.248 & 0.014 \\
-1.623 & -1.607 & -11.24 & 2.064 & -0.31 & -0.71 & -0.576
\end{Bmatrix}
\begin{Bmatrix} lny \\ \Delta lnx1 \\ \Delta lnx2 \\ lnx3 \\ \Delta lnx4 \\ lnx5 \\ \Delta lnx6 \end{Bmatrix}_{t-2} +
$$

$$
\begin{Bmatrix} \widehat{\varepsilon_1} \\ \widehat{\varepsilon_2} \\ \widehat{\varepsilon_3} \\ \widehat{\varepsilon_4} \\ \widehat{\varepsilon_5} \\ \widehat{\varepsilon_6} \\ \widehat{\varepsilon_7} \end{Bmatrix} \tag{1}
$$

According to the above all the variables of unit root test, lny, lnx1, lnx2, lnx4, lnx6 as I (1) vector, lnx3, smooth lnx5 as vectors, so the cointegration test, JJ cointegration test results are shown in table 3 below, according to the characteristics of root trace inspection and maximum eigenvalue, suggests that these variables are there is a cointegration relationship, and there are at least two collaborators whole relationship, but considering the limitations of data acquisition, in this build a VEC model of error correction.

Table 3 JJ co-integration test

Hypothesized No. Of the CE (s)	Eigenvalue	The Trace Statistic (P. * *)	Max Eigen - Statistic (P. * *)
None *	0.890469	191.5328 (0.0000) **	61.92331 (0.0006) **
At most1 *	0.825871	129.6095 (0.0000) **	48.94286 (0.0039) **
At most2 *	0.689867	80.66660 (0.0053) **	32.78116 (0.0671) **
At most3 *	0.568268	47.88544 (0.0497) **	23.51863 (0.1524)
At most4 *	0.418519	24.36681 (0.1854) **	15.18096 (0.2764)
At most5 *	0.229044	15.49471 (0.3485) * *	7.283484 (0.4562)
At most6 *	0.065685	3.841466 (0.1678) **	1.902361 (0.1678)

Note: the addition of "**" indicates rejection of the null hypothesis at a significant level of 5%.

The co-integration relationship reflects the long-term stable equilibrium relationship among variables, but this equilibrium is dynamic and not invariable, and variables may deviate from their long-term equilibrium state in a certain period. When the equilibrium system is hit and the equilibrium is broken, the system will gradually restore to the long-term equilibrium state through a certain error correction mechanism. Therefore, this paper investigates the relationship between variables through the error correction model (VEC), which is a VAR model with co-integration constraints. Without loss of generality, in order to satisfy the first-order integration of variables, the first-order difference is first made to the variables, so that, the VEC model is expressed as follows:$\acute{y} \sim I(1) \Delta \acute{y}_t = \alpha ecm_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta \acute{y}_{t-i} + \varepsilon_t$, type of each equation is a error correction model, which is a vector error correction item, the long-term equilibrium relationship between the response variable, the coefficient matrix reflects the deviating from the long-term equilibrium between state variables, the speed of adjustment to equilibrium, P for the optimal lag, all as explained variables reflect the difference of coefficients of short-term fluctuations in the value of the short-term changes as interpreted variable.$\alpha ecm_{t-1} = \acute{\beta} \acute{y}_{t-1} \alpha \Gamma_i$According to the output of the software, the co-integration equation is as follows:

$$\ln y_{t-1} = 0.601x1_{t-1} + 2.948x2_{t-1} + 1.713x3_{t-1} - 0.162x4_{t-1} - 0.739x5_{t-1} + 0.363x6_{t-1} - 33.99 \quad (2)$$

The co-integration equation shows that under other conditions unchanged, agricultural non-point pollution will increase by 0.601 percentage points for every percentage point increase in agricultural output value. Although agricultural non-point pollution is external to agricultural non-point pollution, the increase of agricultural value still has a certain impact on agricultural non-point pollution. However, in the short term, every percentage point increase in agricultural population size and ratio of livestock and poultry breeding will bring 2.948 and 1.713 percentage points increase in agricultural non-point source pollution, indicating that the ratio of agricultural population size to livestock and poultry breeding has a greater impact on agricultural non-point source pollution. And rational than on them, the increase in the rate of technological progress, would bring a corresponding reduction of agricultural non-point source pollution, which shows that economic crops than food crops to produce big agricultural non-point source pollution, but in recent years under the background of agricultural safe, improving green safe food consumption market will also reduce the use of pesticides and fertilizers; As for agricultural openness, for every percentage point increase in openness, agricultural non-point pollution will increase by 0.363 percentage points, and agricultural foreign trade will further aggravate agricultural non-point pollution.

4. Summary

The empirical results show that the scale effect of agricultural economy has a positive effect on agricultural non-point source pollution, which indicates that the expansion of agricultural production scale and rural population scale will increase the emission of agricultural non-point source pollution. In recent years, the rural population has been decreasing continuously, which can reduce the pressure of agricultural non-point source pollution on the ecological environment to some extent. The increase of the output value of livestock and poultry breeding industry will lead to the aggravation of agricultural non-point source pollution. However, the pollution reduction effect of technological progress and government policies began to play an initial role, both of which can effectively reduce non-point source pollution in agriculture. In addition, in terms of the impact of various factors on agricultural non-point source pollution, both the scale effect of agricultural economy and the effect of agricultural structure have a relatively large impact on agricultural pollution, which provides corresponding theoretical basis for the policy innovation of agricultural non-point source pollution. However, from the perspective of China's previous environmental governance system, it was mainly established for the prevention and control of urban and industrial pollution. "focusing on end-point control and ignoring the source control" did not adapt to the characteristics of agricultural non-point source pollution and could not play a role in the control and management of agricultural non-point source pollution. Although the current government policies are also changing, gradually establish and improve the "source control" as the core of agricultural non-point source pollution management system, but agricultural non-point source pollution is still serious. Is reasonable, therefore, push heavy population flow, optimize the agricultural structure and layout, at the same time constant transformation of the mode of agricultural production and improve the role of technological progress in agriculture reducing the pollution, promoting environmentally friendly agricultural production technology, improve the efficiency of resource utilization, which is by changing the way of agricultural production in solving the problem of agricultural pollution in the process of agricultural development; We will increase investment in rural environmental governance and environmental infrastructure construction and establish a long-term mechanism for agricultural environmental investment. We should establish and improve the policy system for the management of agricultural non-point source pollution, attach importance to the role of economic incentive mechanism in the management of agricultural non-point source pollution, and comprehensively apply a variety of policy tools.

References

[1] Tsuzukiy. An index directly indicates land-based pollutant load contributions of domestic waste water to the water pollution and its application [J]. Science of the Total Environment, 2006, 370:425-440.

[2]Grossman, G.M.and Krueger, A.B.:Environmental Impacts of A North American Free Trade Agreement, Woodrow Wilson School, Princeton, NT, 1992.

[3]Roca, J.; Padilla, E.;Farre, M.;Galletto, V.: Economic Growth and Atmospheric Pollution in Spain:Discussing the Environmental Kuznets Curve Hypothesis, Ecological Economics, 39:85-99, 2001.

[4] Hui Zhang, Hao Hu. Environmental kuznets curve verification of agricultural non-point source pollution -- based on the analysis of time series data of Jiangsu province[J] Chinese Rural Economy,2009(4):48－53

[5] Jihong Ge, Shudong Zhou. Analysis of economic influencing factors of agricultural non-point source pollution -- based on the data of jiangsu province from 1978 to 2009[J]. Chinese Rural Economy,2011(5):72－81