The Forecast of Fisheries Development in Liaoning Province --Regression Analysis Based on LOGISTIC Model and ARMA Model

Zhou Jing[1], Zhao Yang[1], Li Ke[1] and Wang Bo[2]
Shenyang Agricultural University[1] Dalian Fisheries University[2]

Abstract

Fishery industry is an important component of the agricultural industry in Liaoning Province. The development of the fishery industry plays a significant role on a steady and rapid development of the agricultural economy in Liaoning Province. In this paper, based on the fishery total output value in Liaoning Province from 1978 to 2007, it has first been established for fishery output value growth model in Liaoning. With the aid of the influence factor of the fishery total output value analyzed by the model of LOGIT, the future fishery total output value of Liaoning Province has been forecasted. Then, the characteristics of annual fishery total output value data in Liaoning Province are analyzed by using the Eviews software. An Autoregressive Moving Average (ARMA) model is established which provides a reference tool for the prediction of annual fishery output values in Liaoning Province. The forecasting result indicates that fishery output value in Liaoning Province will have relatively big substantial room for growth in the future several years. But its rate of rising will reduce speed gradually.

Key words: fishery total output value; LOGIT model; ARMA model; model prediction

1 Introduction

Fishery plays an important role in Liaoning Province of China, which possesses rich resource of fishery and has the foundation of fishery industry, the market conditions and other advantages. It has a brightly prospect in fishery. With the development of reform and opening-up in China, fishery total output value in Liaoning Province in the proportion of total agricultural output is also gradually improving. “Fishery has gradually become one of the pillar industries in the agricultural economy of Liaoning Province”[1]. The development of fishery industry is conducive to the adjustment of the agricultural structure, to the improvement of the rural economy and to the increase of the farmers' income. The goal of this paper is to establish the forecast model of the fishery total output value using the method of regression analysis for the historical statistical data of fishery in Liaoning Province, to explain the economic significance of the various parameters in the model and to analyze the influence factors of the mutative parameters for the economic development according to the principle of economics. And then propose the corresponding policy and suggestions in advance for the development of the fishery industry in Liaoning province.

2 Regression Analysis of Trend Based on LOGISTIC Model

2.1 Model and related Theories

LOGIT model, known as the LOGISTIC regression model, is a class of discrete choice model developed gradually in the first half of the 20th century abroad. It has obtained a widespread application in biology, economics, psychology, political science, and transportation. In China, the examples of the application of LOGIT model in economics and management literature are relatively small. Several examples of the application of LOGIT model are seen on the risk analysis of default customers in banks. The papers about the forecast research of the output value model by the LOGIT model are seldom seen. The paper is the research about forecasting the development of the farming and animal husbandry fishery in our country by the LOGIT model. The result of model of [5]shows that the fitting degree from the values of the model to the farming and animal husbandry fishing total output value are better comparing with other analysis tools. This is the reason why the LOGIT model is selected for the analysis of the forecast profession output value in the paper.

The general form of LOGISTIC model：

$$y = L / (1 + a * e^{-(\ln b)t}) \tag{1}$$

where L is the biggest limit value of the curve, b is the growth factor of the curve and a is the dilation factor of the curve [2].

In order to achieve the estimation the formulae (1) will be written as follow:

$$L_i = \ln[P_i / (1 - P_i)] = \beta_1 + \beta_2 X_i + u_i$$

Then we use the weighting least squares to establish the confidence interval and the examination supposition [3].

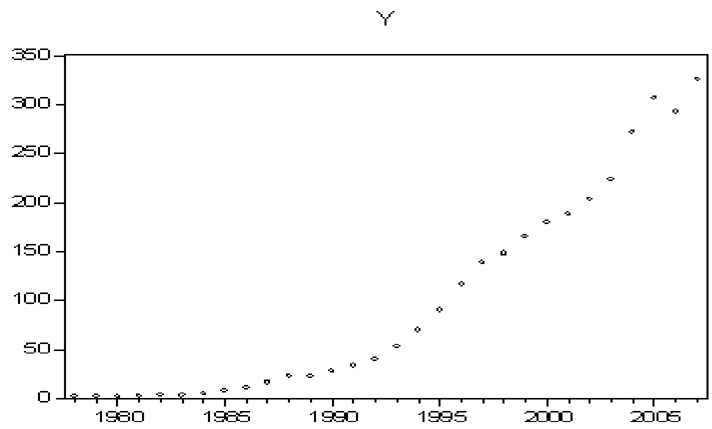
2.2 Empirical Analysis

2.2.1 Data interception

Before the reform and opening up policy is implemented, the fishery total output value data change tendency of Liaoning Province is not obvious because of the shiftless fishing industry establishment, lower skill levels and other disadvantages. So the annual data of fishery total output value from 1978 to 2007 in Liaoning Province are selected for analyzing in the paper(Source: Liaoning Statistical Yearbook[4]).

2.2.2 The model' s establishment and parameter' s estimation

The scatter diagram of the series data of fishery total output value in Liaoning Province is given in Figure 1.



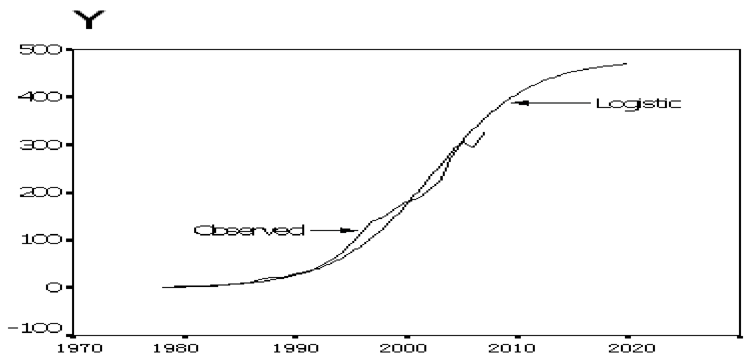
(Origin: Obtains by the SPSS13.0 computation)

Figure 1 Scatter plots of fishery total output value in Liaoning Province (hundred million Yuan)

According to the supposition of the regression analysis and the function form for the scattered data, Liaoning Province fishery total output value has the most greatly possible value, namely the maximum value. And the fishery total output value has certain growth speed. It has the following possible LOGIT function form:

$$y = L / (1 + a * e^{-(\ln b)t})$$

Where L is the biggest limit value of the curve (the possible maximum fishery total output value), b is the growth speed factor and a is the dilation factor of the curve (the function intensities of the diffusion factor and fishery system intrinsic transaction cost). According to these three parameters, the value of y can be estimated by the changing tendency of the statistical data approximately. The LOGIT simulation model of Liaoning Province fishery total output value is established by using the SPSS software on Figure 2 [5].



(Origin: Obtains by the SPSS13.0 computation)

Figure 2 the data of fishery total output value in Liaoning Province and its required value from the evolved model (hundred million Yuan)

With the aid of the econometrics SPSS13.0, the optimized estimate of the regression function's parameters of the statistical data are obtained. And a precise complete expression of the regression function about the statistical data is given. In the actual operation process, this step has been carried for many times because of the need of better fitting degree of the equation and the smaller residual difference. Finally the obtaining optimized parameters are : L=478，a=40738985.255816，b= 0.793528。R^2=0.98724，S.E.=0.23552，F = 2167.07798，Residuals=1.55314.

Therefore the evolvement model of Liaoning Province fishery development is (hundred million Yuan):

$$y = 478/(1+40738985.255816 * e^{-(\ln 0.793528)t})$$

2.2.3 Economic Prediction

According to the above analysis and the fitted curve the prediction values of fishery output value of Liaoning in the next ten years are obtained on Table 1 and Figure 3.

Table 1 Prediction of the annual fishery output values in Liaoning Province from 2008 to 2020

(Unit: hundred million Yuan)

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
374.4	391.9	407.1	419.9	430.7	439.7	447.1	453.2	458.1	462.1	465.3	467.8	469.9

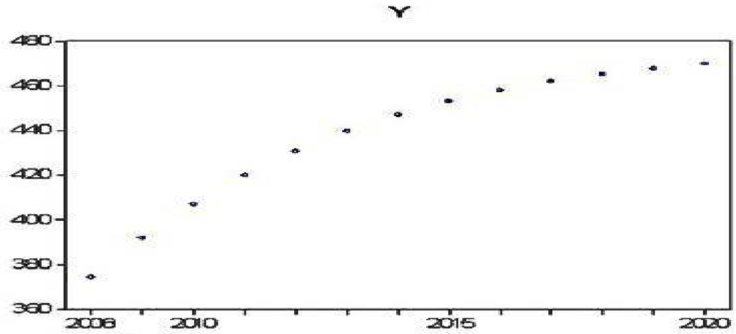


Figure 3 Scatter plots of prediction of the annual fishery output value in Liaoning Province from 2008-2020 (hundred million Yuan)

The result shows that the prediction of the fishery total output values in 2008 is 374.4 hundred million Yuan. Comparing with the real value 374.5 hundred million Yuan in 2008, the absolute error from the prediction to the real value is 0.12 Yuan and the relative error of them is only $3.2e^{-4}$.

3 The analysis of non-trend based on ARMA model

3.1 Model and related Theories

ARMA model becomes a prevalent single time series model in the world at present . It is particularly suitable for predicting complex time series. The precision of short-term prediction using ARMA model is better and this model has wide application in many fields such as the analysis of fisheries resource, the forecast of data economy and the construction of mathematical models.

3.1.1 The general form of ARMA model

ARMA model means that at a certain moment the response to a system is depending on both its own previous value and the previous disturbance. It is a model that established only by its own past values of the time series and the stochastic disturbance. [6]The general form of ARMA model is as follow:

$$Y_t=\varphi_1 Y_{t-1}+\cdots+\varphi_p Y_{t-p}+\varepsilon_t-\theta_1\varepsilon_{t-1}-\cdots-\theta_q \varepsilon_{t-q} .$$

(Y_t: the observation of period t; p, q: lag term; ε_t : the disturbance of period t; φ, θ: coefficient) [7]

3.1.2 Related Theories

(1) The stationary test and the stationarize processing of the time-series.

To establish the ARMA model, testing the stationary of the series according to figure of illustration and unit root test is necessary, for most of the time series being non-stationary. Using figure of illustration we can judge the stationary of the series roughly. Generally speaking, the graphics of the stable time series shows a process that fluctuating around its mean value. Otherwise the graphics of non-stable time series has different means at different time (such as continuously rising or descending).Further more, it is more accurate using the statistical test such as unit root test which is widely used in statistic testing.

The stationarize processing usually adopts the logarithm or difference equation. The logarithm method will be used if the series shows an exponential trend. The difference equation will be applied if there is a linear trend in the series.

(2) The model's form and the judgment of order.

The form and order of the model can be initially identified by the autocorrelation function and partial autocorrelation function figures. We use Akaike Information Criterion (AIC) and Schwartz criteria (SC) to determine the order of the model. That is, as far as possible select the one whose values of AIC and SC are the smaller. To eliminate autocorrelation the values of D.W. in the non-auto-correlation area must be selected.

3.2 Empirical Analysis

In this paper, we use the annual data which based on the fishery total output value in Liaoning Province from 1978 to 2007.

3.2.1 The stationary test and the stationarize processing

Firstly, the line chart can be made that the horizontal axis is labeled with years from 1978 to 2007 and the vertical axis shows fisheries GDP of Liaoning Province(see Figure 4).

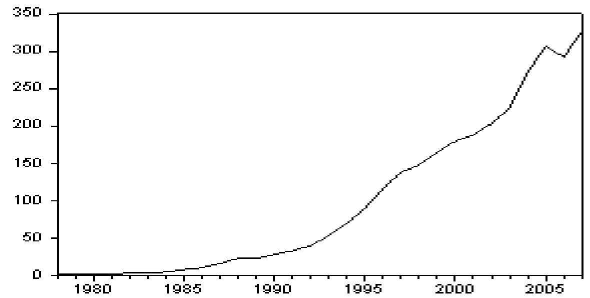


Figure 4 The line chart of a fishery total output value in Liaoning Province from 1978 to 2007

From Figure 4 we can see the fishery total output value in Liaoning Province showing a clear growth trend with non-stationary.

Secondly, By Eviews software testing the unit root of the data,[8] The testing results are in Table 2.

Table 2 The results of ADF test to Y

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.378010	0.9771
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

Because the Augmented Dickey-Fuller (ADF) value (= 0.378010) is apparently more than the thresholds at three different significant levels. This leads our judgment that the time series of the fishery total output value of Liaoning Province is non-stationary. To stationarize the data, different methods are used in this paper. First of all, execute one-order difference to the original series Y (the fishery total output value of Liaoning Province) and get the one-order difference series (dY) of the series. Then do ADF testing for dY and the results are in Table 3. Unluckily the series in Table 3 are still not stable. So execute differential operator to the series dY again and get second-order different series ddY. By observing the line chart (see Figure 5) and the results of ADF test (see Table 4), as well as auto-correlation and partial auto-correlation figures (see Figure 6), we convince the second-order different series ddY is stable.

Table 3 The results of ADF test to dY

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.434053	0.8866
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

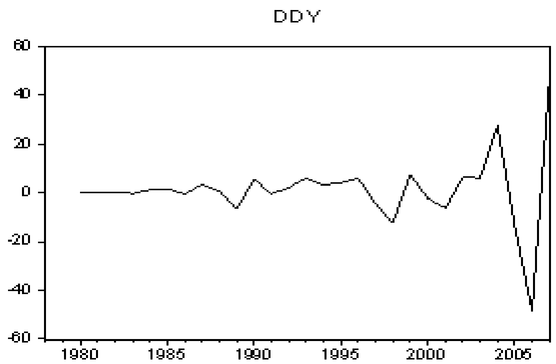
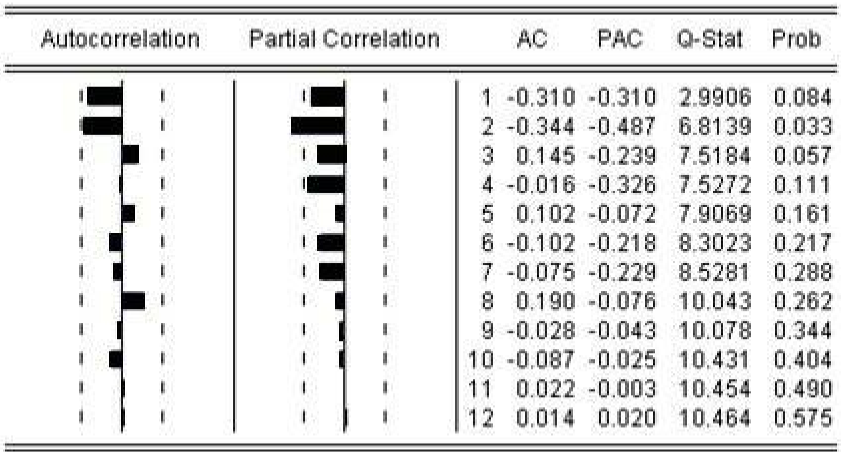


Figure 5 The line chart of ddY

Table 4 The results of ADF test to ddY

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.079169	0.0006
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.310	-0.310	2.9906	0.084
		2	-0.344	-0.487	6.8139	0.033
		3	0.145	-0.239	7.5184	0.057
		4	-0.016	-0.326	7.5272	0.111
		5	0.102	-0.072	7.9069	0.161
		6	-0.102	-0.218	8.3023	0.217
		7	-0.075	-0.229	8.5281	0.288
		8	0.190	-0.076	10.043	0.262
		9	-0.028	-0.043	10.078	0.344
		10	-0.087	-0.025	10.431	0.404
		11	0.022	-0.003	10.454	0.490
		12	0.014	0.020	10.464	0.575

Figure 6 The auto-correlation and partial auto-correlation figures of ddY

3.2.2 The estimation and determination of the model

According to the autocorrelation function and partial autocorrelation function figures (Figure 6) of the series ddY, we can see that the Q-Stat value all pass Q-Test, and the form and order of the model can be initially identified. In order to establish a more appropriate model, we test a number of models. The best model selecting mainly depends on the values of D.W. and AIC. According to the AIC and SC order determination criteria we select the one which the values of AIC and SC are smaller and the D.W. value ranges between 1.48 and 2.52 so as to eliminate autocorrelation. After comparing the data we select the AR (2) MA (1) model. Using Eviews we get the following concrete model:

$$ddY_t=1.099472-0.740283ddY_{t-2}-0.9278286\varepsilon_{t-1}$$

(5.981725) (-2.588309) (-14.10176)

$R^2=0.608458$ D.W.= 1.696118 F=17.87103 S.E.= 10.16667

The expansion of the model is as follow:

$$Y_t=1.099472+2Y_{t-1}-1.740283Y_{t-2}+1.480566Y_{t-3}-0.740283Y_{t-4}-0.9278286\varepsilon_{t-1}$$

3.2.3 Prediction

From Figure 7 we can see the residual of the model is relatively stable which illustrates that the model passes the stationary test. At the same time, the true value and the predictive value are fitting well. The trend of the prediction accord with the actual one too.

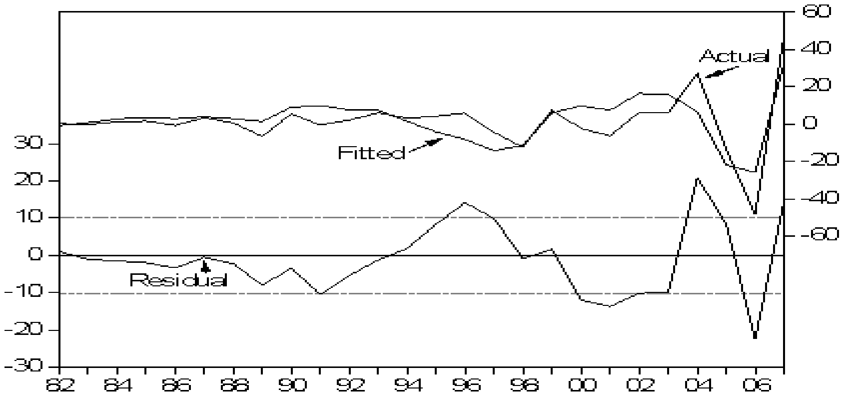


Figure 7 The value of residual, actual and fitted

Using the model we give our prediction on the fishery total output value from 2008 to 2020 and the results are on Table 5 and the line chart on Figure 8.

Table 5 Prediction of the annual fishery output value in Liaoning Province From 2008 to 2020 (Unit: hundred million Yuan)

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
388.0	415.7	423.6	457.8	507.8	539.4	560.4	596.1	640.8	675.7	705.1	742.8	785.7

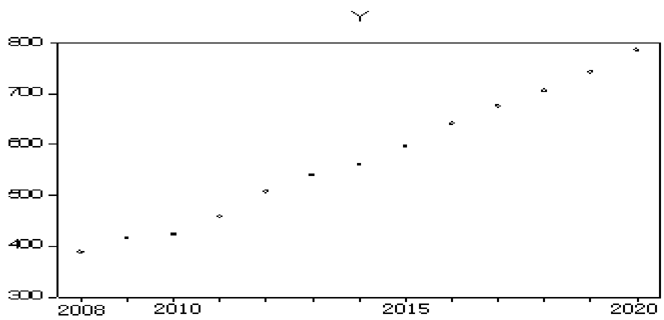


Figure 8 The line chart of prediction

The result shows that the prediction of 2008 is 388 hundred million Yuan. Comparing with the real value 374.5 hundred million Yuan in 2008, the relative error from the predicted value to the real value is 3.6%.

4 Conclusions

In this paper, based on the fishery total output value in Liaoning Province from 1978 to 2007, it has been analyzed by LOGISTIC Model and ARMA Model. According to the predictions of the two models, we have come to the fishery total output value of Liaoning Province is between 407.1 and 423.6 hundred million Yuan in 2010, between 453.2 and 596.1 hundred million Yuan in 2015 and between 469.9 and 785.7 hundred million Yuan in 2020. According to model prediction, the fishery total output value in Liaoning Province will grow continually for several years unless domestic and foreign wars happen or under the serious natural disaster condition. It has a very big substantial room for growth. It already entered the high speed rise period from the steady growth and will continue this situation by high speed. But the rate of increment will decelerate gradually.

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