Environment & Ecology 35 (3D) : 2423—2426, July—September 2017
Website: environmentandecology.com ISSN 0970-0420

A Study on Dynamicity of Data on All-India Marine Products Export over the Years

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Received 24 October 2016; Accepted 26 November 2016; Published online 14 December 2016

Abstract In the present study, an attempt has been made to model the dynamicity of the data on exports related to all-India marine products and based on a model constructed on the above data-set (1961-62 to 2013-14). Some non-parametric models have been compared with different parametric models in order to judge their precision by measuring the proximity between the observed and the predicted values based on the data-sets data on exports related to all-India marine products. The importance of such studies stems from the fact that the policy makers need the specialized scientific information in the form of advisory services in respect of the pattern of export over the years in advance and identification of specific model helps to obtain such important information. This paper is devoted to generate such models. It is revealed that the precision levels are much higher when the non-parametric models are applied on the data-sets considered under the purview of the paper, in comparison to other methods exploited to obtaining the above-said information.

Keywords Parametric, Loess, Spline, Dynamics.

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Introduction

Fisheries sector plays a very crucial role in national economy. The marine fisheries sector in India has witnessed a positive growth during the last five decades [1]. With a vision to develop marine products exports, the Marine Products Export Development Authority has been trying to explore in technically and economically feasible technologies to Indian entrepreneurs. Fishing has turned a big market [2] industry in India. India is endowed with rich marine fisheries resources. According to the Ministry of Agriculture, Government of India, more than six million people depend on marine fisheries for livelihood. It supports about one million fishermen. It continues to be a thrust area of India's development programd due to its vital contributions to employment generation, food security and foreign exchange earnings. During the financial year 2014-15, exports of marine products reached an all-time high of USD 5511.12 million. Marine product exports crossed all previous records in quantity, rupee value and USD terms [3]. Moreover, marine export earrings account for one fourth of total agricultural foreign exchange earnings of our country . The export of marine products can play for imports of capital goods, technology, manufactured products and other essential commodities for a sustained growth of developing countries. Many developing countries have a comparative advantage in the production of marine products and export of these goods is the main source of foreign exchange earnings. In an export led growth model of trade it would be to the advantage of the developing countries to specialize in production of those goods where they have comparative advantage and to exploit the surplus production to earn the valuable foreign exchange. Such a policy will led to use trade as an engine of growth, as well as in ensuring rational allocation of resource. India, which is predominantly a fisheries economy, is no exception in this regard.

In view of the setting up of that target, it becomes imperative to critically analyze the all-India marine products export data, using appropriate statistical modeling procedures. Such studies will be able to build in formulating suitable strategies for planning and developing future export of marine products in the form of advisory services in respect of the pattern of export over the years. Some isolated attempts have already been made in the past to explore the trends in marine products export. The techniques used are : (a) graphical approach and (b) polynomial function fitting approach analyzed India's seafood export [4] trend by using simple linear regression analysis on the data for the period 1970-90. On the basis of this model, they also projected the total sea food export during successive years up to 2000 A.D.

Accordingly, in this paper, our aim is to develop a suitable statistical model for describing the trend in all-India marine products export by employing different techniques of statistical modeling, namely, (i) Nonlinear mechanistic growth modeling [5] approach and (ii) Nonparametric and (iii) Semi parametric methodology.

Materials and Methods

Data on all-India marine products export during 1961-62 to 2013-14 available in the reports of Fisheries Division, Ministry of Agriculture (Govt, of India) is used for the analysis. The data, were modeled by applying parametric, non-parametric and semi-parametric [6] methods. The goodness of fit of the model is assessed by computing Akaike's Information Criterion (AIC). The Akaike information criterion (AIC) is a measure of the relative goodness of fit of a mathematical model for describing data patterns. It can be used to describe the tradeoff between bias and variance in model construction and to assess the accuracy of the model used. In this work, attempts have

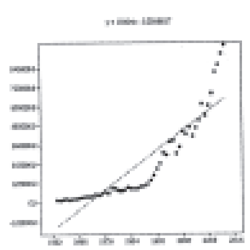

Fig. 1: Linear model

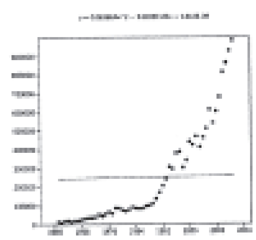

Fig. 2: Quadratic model

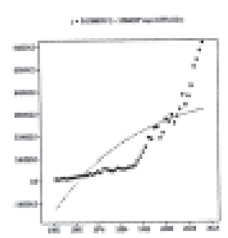

Fig. 3: V- B Model

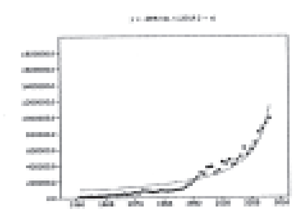

Fig. 4: Michaelis Model

Fig. 1. Linear model, **Fig. 2.** Quadratic model, **Fig. 3.** V-B model, **Fig. 4.** Michaelis model.

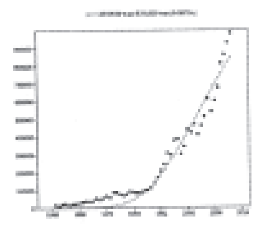

Fig. 6: Logistic model

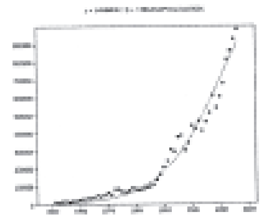

Fig. 5: Gompertz model

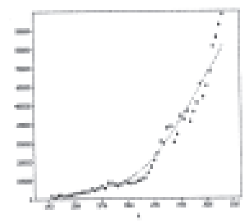

Fig. 7: LOESS model

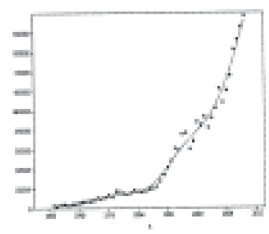

Fig. 8: Spline model

Fig. 6. Logistic model, **Fig. 5.** Gompertz model, **Fig. 7.** LOESS model, **Fig. 8.** Spline model.

been made to apply parametric and non-parametric regression techniques to formulate models in respect of export of marine products. The different parametric models used are described below.

Parametric method

Models can broadly be categorized into-linear and non-linear. Different models like simple regression model, quadratic model, von bertalanaffy model, michaelis model, logarithmic model, gompertz model, logistic model have been tried (Fig. 1–6).

Non-parametric method (LOESS-known as locally weighted polynomial regression model)

In the LOESS method, weighted least squares are used to fit linear or quadratic functions of the predictors at the centers of neighborhoods (Fig. 7). Data points in a given local neighborhood are weighted by a smooth decreasing function of their distance from the center of the neighborhood.

Semi parametric method (SPLINE) :

In the semi-parametric set up, a parametric part, say, a linear function is added in the model and the penalized least squares estimate is called upon. (Table 1) (Fig. 8) Let x_i be a *d*-dimensional covariate row vector, z_i be a *p*-dimensional covariate row vector, and y_i be the observation associated with the set (x_i, z_i), Assuming that the relation between z_i and y_i is linear but the relation between x_i's and y_i's is unknown, one can fit the data using a semi-parametric model as follows:

$$y_i = f(x_i) + z_i \beta + e_j$$

Where f is an unknown function that is assumed to be reasonably smooth, e_i's, i = *1, 2,...n,* are independent, zero-mean random errors and β is a *p*-dimensional unknown parametric column vector. For most of the functions the Levenberg-Marquardt optimization has been tried. The Akaike Information Criterion (AIC) may aid in the selection of model. Lower

Table 1. Forms of different parametric models.

Model	Form
Linear	$b_0 + b_1 t$
Quadratic	$b_0 + b_1 t + b_2\, t^2$
Von Bertalanaaffy	$Y = a\ (I\text{-}be^{-cx})$
Michaelis	$Y=ax/\ (b+x)$
Gompertz	$Y_t = ab^{ct}$
Logistic	$Y_t = \frac{k}{l + e^{a+bt}}$

Table 2. AIC criteria of different fitted model.

Sl. No	Model	AIC
1.	Linear	7.17E + 11
2.	Quadratic	3.36E + 12
3.	Von Bertalanaaffy	1.38E + 12
4.	Michaelis	3.37E + 11
5.	Logistic	1.01E + 11
6.	Gompertz	1.63E + 11
7.	Loess	4.99E + 02
8.	Spline	4.71E + 02

values for the AIC imply a better fit, adjusted for the number of parameters.

Results and Discussion

Among the parametric models fitted it is observed that the best fitted models are found to be Logistic based on the AIC criterion which is least among all the parametric methods. In this paper, along with the parametric models, one non-parametric and one semi-parametric model have been tried. The AIC values which are presented in the Table 2 indubitably confirm the superiority of the representative power (in terms of higher precision or less AIC values) of the non-parametric and semi-parametric modeling in comparison to parametric modeling, when called for, in situations to depict the pattern of marine export. The best fit for the above mentioned marine data is offered by non parametric regression methods called LOESS or semi-parametric methods called SPLINE which computationally very intensive program calculates the best fit polynomials from subsets of data set in order to eventually find out the best fit curve for the overall data set. The graphs of the different models are also given below. The graphs of semi-parametric (FIg. 8) and non-parametric models (Fig. 7) precisely depict the dynamics of the marine export data over parametric models.

The implication and importance of this study are that the non-parametric model (Loess) and semi-parametric model (Spline) are capable to produce exact dynamics at any time point most precisely so as to provide accurate advisory services to fisheries sector, an advance knowledge of which is of utimost help to the sector. Also, it is reassuring to observe that both Loess and spline provide a better fit to non-linear data than doe's traditional modeling. It is no denying that to model the dynamics evidenced in temporal real-life data situations, the nonparametric and semi-parametric models offer better representations almost often.

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