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Modelling and forecasting of India's shrimp export

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Abstract

All - India shrimp export data is modelled via a new promising approach, viz. "Structural Time-series Modelling". The series under consideration follows an autoregressive process. This procedure is subsequently compared with the well known Auto Regressive Integrated Moving Average (ARIMA) methodology. It is found that the former technique performs much better than the latter, as judged by various goodness of fit criteria. Finally, identified model is used to forecast shrimp export for the next five years.

India ranks fifth among world exporters of marine products (Suri, 1995). Presently, in terms of value, major markets for these products are : Japan (47 %), U.S.A. (11%), and China (6%). Among the major marine product items exported from India during 1999-2000, shrimp is predominant with a share of 32.1% in terms of quantity and 71.2% in terms of value. Major markets for shrimp are : Japan (62.8%), European Union (17.3%) and U.S.A. (13.1%). Some studies have been undertaken in the past to study the trend in marine products or shrimp export. Alagaraja and Srinath (1980) fitted a mutliple linear regression model by treating shrimp landings as dependent variable against export and years as independent variables. Yogamoorthi and Sivashankar (1994) analyzed India's seafood export trend by using simple linear regression technique. Venugopalan and Prajneshu (1996) compared Polynomial function fitting approach, Nonlinear mechanistic growth modelling procedure, and ARIMA time-series methodology and found that this approach is best for describing all - India marine products export data for the period 1960-61 to 1994-95. However, one drawback with ARIMA methodology is that the underlying series is assumed to be stationary or can be made so by differencing or detrending : this may not always be possible.

Harvey (1996) proposed a new promising methodology, viz. "Structural Time-series Modelling" which overcomes the above drawback. The essence of this approach is that it attempts to represent the main features of the given data. Components such as trends and cycles are or are not included in the model depending upon their presence or absence in the data; this ensures to produce a plausible model at the outset. Accordingly, purpose of this paper is to model and forecast the all - India shrimp export data. The presence of autocorrelations among successive observations is quite likely. Therefore, the methodology is applied when the series under consideration follows an autoregressive process (Harvey and Phillips, 1979). Results obtained are compared with the well-known Auto Regressive Moving Average (ARIMA) methodology (Box *et al* 1994). Identified model is then used to forecast shrimp export for the next five years.

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Material and methods

Fifteen years' (1985-86 to 1999-2000) time-series data of all - India shrimp export (Table 1) is utilized for the present study. A perusal of data indicates that there are no cyclical fluctuations. Further, the data is on an annual basis, seasonal component is also not present. Thus, in the presence of only trend(μ) and error component (ε_t) the "Structural time-series model" can be written as

$$Y_t = \mu_t + \varepsilon_t, \quad t = 1,2,....,T \qquad .....(1)$$

where $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$. Further, first order autoregressive process is introduced in the model by putting

$$\mu_t = \varphi_1 \mu_{t-1} + w_t \qquad ...(2)$$

Where φ_1 is the AR (1) parameter and $W_t \sim N(0, \sigma_W^2)$. Eq. (1) is called the "observation equation". Eq. (2) is called the "state equation", since it describes the manner in which the state of a system at time t, say μ_t, is determined from the state of the system, μ_{t-1} at time t-1 In eqs. (1) and (2), ε_t and w_t can be thought of respectively as "observation noise" and "model noise"; the relative importance of these two noise components can be controlled by specifying values for the variances σ_ε^2 and σ_ω^2. The initial value μ_0 is assumed to be a random variable with mean m_0 and variance. For the estimation of parameters in eqs. (1) and (2), these have to be put in state space form (Meinhold and Singpurwalla, 1983). In that situation, estimation of parameters in the state vector is carried out using Kalman filter, prediction and smoothing (Harvey, 1996). The hyperparameters σ_ε^2 and σ_ω^2 are assumed to be known, otherwise these can be estimated using Prediction error decomposition (PED) method or by Expectation maximization (EM algorithm) (Shumway and Stoffer, 2000). The reduced form from ARIMA family corresponding to eqs. (1) and (2) is ARIMA (1,0,0) or AR (1) model.

Table 1. *All - India export of shrimp*

Year	Export (in thousand tonnes)
1985-86	50.3
1986-87	49.2
1987-88	55.7
1988-89	56.8
1989-90	7.8
1990-91	62.4
1991-92	76.2
1992-93	74.4
1993-94	86.5
1994-95	101.8
1995-96	95.7
1996-97	105.4
1997-98	100.7
1998-99	102.5
1999-00	110.3

Goodness of fit of the above models are assessed using Akaike information criterion (AIC), Schwartz - Bayesian information criterion (SBC) and Standard error (SE). Lower the values of these statistics, better is the fitted model.

Results and discussion

In the first instance, a structural time-series model given by eqs. (1) and (2) is fitted to the data using STAMP software package, Version 6.0, and downloaded from the internet site http://www.econ.vu.nl/STAMP.htm. Parameter estimates and goodness of fit statistics are presented in Table 2. Subsequently ARIMA (1, 0, 0), i.e. AR (1) model is fitted to the data set using Statistical Analysis System (1990) software package, Version 6.12. The estimate of AR (1) parameter is obtained as 1.0 while the goodness of fit statistics are:

AIC = 108.86, SBC = 110.27, SE = 8.57

Therefore, a reduction of 48% in AIC is achieved by employing structural time-series model with AR (1) process. Thus, this model performs much better than its ARIMA counterpart for the data set under consideration. To get visual insight, the graph of fitted model along with data points is exhibited in Fig. 1. Finally, forecast values for the next five years based on structural time-series modelling is presented in Table 2.

Conclusions and recommendations

In India, export of marine products presently contributes nearly 25% of gross national product from agriculture. Of this, shrimp contributes a major share to the basket of foreign exchange earnings. Therefore, an efficient modelling and forecasting will go a long way in helping the policy makers to frame appropriate export policies. It is hoped that, with global liberalization and setting up of World Trade Organization, export of various fish and fish products would

Table 2. *Summary statistics for structural time series model*

Parameter	Estimates
(i) Fitting of model	
Level(μ_t)	113.74
φ_1	113.74
σ^2_ε	20.27
σ^2_ω	8.68
(ii) Goodness of fit statistics :	
AIC	56.95
SBC	57.69
SE	5.84
(iii) Forecast (in thousand tonnes)	
2000-01	113.50
2001-02	118.13
2002-03	122.37
2003-04	126.72
2004-05	131.04

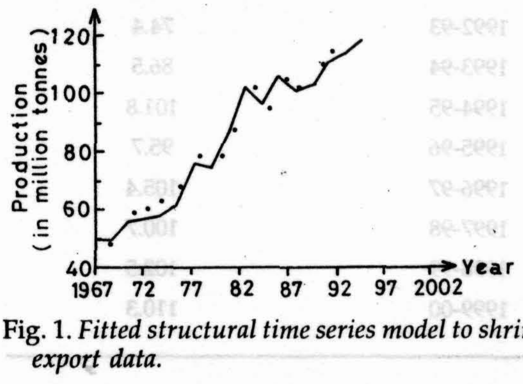

Fig. 1. *Fitted structural time series model to shrimp export data.*

witness a phenomenal growth rate in future. Under this scenario, other fish species would also exhibit quantum Jump in their exports and would become important from economic point of view. In view of all this, modelling and forecasting of export data dealing with single-species as well as multi - species is highly desirable and to this end, the methodology advocated in the present paper would, hopefully, be extremely useful.

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