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SHORT-TERM FORECASTING: An Application of Box-Jenkins Methods

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Shaikh and Zaman (1983) have used time series methods to forecast basmati rice exports in Pakistan. This paper re-examines the techniques used by these authors. Shaikh and Zaman predicted an increase in exports, from 261.808** in 1981–82 to 290.418 in 1982–83. Albeit, the actual exports declined to 237.739 in 1982–83. Our model, on the other hand, correctly picked the pattern and the forecast for 1982–83 is quite close to the actual value, i.e., 238.18. Our results clearly indicate that proper application of time series methods significantly improves the quality of forecast.

I. Introduction

The forecasting of time series data has made rapid development in recent years. The key factors in explaining this development are the growth of forecasting techniques and easy access to computing facilities. Both business managers and economists require forecasts of many events in formulating policies. Quantitative forecasting methods can be classified into two broader groups: time series and casual. The former method is based solely on the historical pattern of the time series variable to the forecast, while the latter method involves identification of other variables related to the variable to be predicted.

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**Units mentioned in this paper are in thousand metric tons.

Recently Shaikh and Zaman (1983) have used various time series methods, that mainly include a first order auto-regressive model and exponential growth model to forecast basmati rice exports from Pakistan. They have made predictions for rice exports for the years 1982–87, albeit their approach is very casual. First, they have totally ignored the fact that the time series for exports was non-stationary and some differencing was required before estimating the auto-regressive model and secondly, they did not use any identification techniques of the Box-Jenkins method to specify a more formal time series model.

The Box-Jenkins technique has been used in this paper to forecast basmati exports for the years, 1983–84. Although more recent data on exports was available at the time of this study, we have chosen to use, for comparison purposes, exactly the same data base as employed by Shaikh and Zaman i.e., 1958–81.

II. Results

The first step in analysing a time series is to study if the series is stationary. The data on basmati exports in Figure 1,[1] clearly indicate an upward trend in the average. The sample autocorrelation function (AC), in Table 1, dies down slowly and we again conclude that the time-series is non-stationary in the mean.[2] We therefore take the first difference of the series and re-examine the autocorrelation function. The results in Table 2 show that the function dies down towards zero. Consequently the class of ARIMA (p, 1, q) is identified as an appropriate class of models. We used the TSP computer package to estimate ARIMA models with various values of 'p' and 'q' and compared them on the basis of "goodness of fit".[3] ARIMA (3, 1, 4) was the best in terms of adjusted $\bar{R}^2$. The coefficients of the moving average, when q = 1, 3, were insignificant and therefore we have dropped them. The final results of the estimated model are presented in Table 3. In this table we report three coefficients of the AR term (p=3) and two coefficients of the MA term.

We used these estimated parameters to make two period forecasts and compare them with actual data. We also compare our forecast with

[1] The data on rice exports for Pakistan (1958–81) has been taken from Shaikh and Zaman (1983).

[2] O'Donovan (1983), Chapter 4.

[3] We have also tried other variations of ARIMA models but ARIMA (3, 1, 4) was the best in terms of "goodness of fit". It may seem that AR1 would have worked pretty well since $\emptyset_1$ was the only significant coefficient (Table 3). However the adjusted $\bar{R}^2$ for AR1 was only 7 per cent which is clearly not satisfactory.

TABLE 1

Original Series

Autocorrelations	Partial Autocorrelations		ac	pac
*****	*****	1	0.5070	0.5070
**	*	2	0.2157	−0.0557
***	***	3	0.3266	0.3232
***		4	0.3101	0.0224
**		5	0.1620	−0.0192
	**	6	−0.0452	−0.2470
**	**	7	−0.1910	−0.2314
***	***	8	−0.3257	−0.3428
**	**	9	−0.1961	0.1608
**	*	10	−0.2043	−0.0697
***	*	11	−0.3420	0.0680
**	*	12	−0.2440	0.1161
**		13	−0.1531	−0.0073
*	*	14	−0.1411	−0.1022
*	*	15	−0.1396	−0.1427

S.E. of Correlations 0.2425356 Q-Stat. (15 lags) 16.94447

TABLE 2

First Difference of the Original Series

Autocorrelations	Partial Autocorrelations		ac	pac
***	***	1	−0.2569	−0.2569
*****	*****	2	−0.4669	−0.5706
**	**	3	0.1891	−0.2316
*	***	4	0.0909	−0.2974
		5	0.0344	−0.0121
	*	6	0.0051	0.0650
*	*	7	−0.0687	0.1369
**	***	8	−0.2349	−0.3127
**	**	9	0.1878	−0.1653
*	***	10	0.1484	−0.2732
*	*	11	−0.1370	−0.1059
*	*	12	−0.0608	−0.1054
		13	0.0306	0.0148
*	*	14	0.1043	0.0903
*	*	15	−0.0654	−0.0546

S.E. of Correlations 0.25 Q-Stat. (15 lags) 7.759777

TABLE 3

Results of ARIMA Models

Parameters	ARIMA (3, 1, 4)
$\emptyset_0$	17.740
	(2.960)
$\emptyset_1$	−0.717
	(−2.810)
$\emptyset_2$	−0.854
	(−1.681)
$\emptyset_3$	−0.495
	(−1.960)
θ_1	—
θ_2	−0.575
	(−1.090)
θ_3	—
θ_4	−0.519
	(−1.220)
R^2	0.683
$\bar{R}^2$	0.525

Note: ARIMA (p, i, q) can be written as:

$$Z_t = \emptyset_o + \emptyset_1 Z_{t-1} + \ldots\ldots\ldots + \emptyset_p Z_{t-p} - \theta_1 A_{t-1} \ldots\ldots\ldots - \theta_q A_{t-q}$$

where Z_t is the first differencer of the original series and A_t are residuals. In parentheses we report the t−ratios.

TABLE 4

Two Period Forecast for Basmati Rice Exports

Years	Actual	S-Z Model*	M-N Model**
1981−82	261.808	—	—
1982−83	237.739	290.418	238.180
1983−84	405.929	322.154	352.088

*Shaikh-Zaman Model
**Mahmud-Nishat Model

the Shaikh and Zaman results. The first period forecast, for the year 1982–83, is amazingly close to the actual value (237.739 compared to 238.18). While the Shaikh and Zaman model predicted an increase in exports from 261.808 in 1981–82 to 290.418 in 1982–83, our model, on the other hand, has correctly picked the pattern and indicated a decline in exports for 1982–83. Similarly our forecast for 1983–84 is closer to the actual value than what has been forecast by Shaikh and Zaman. We have only used this model to forecast two periods because ARIMA models are useful for short-term forecasting.

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