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FORECASTING OF INDIAN AGRICULTURAL EXPORT USING ARIMA MODEL

Megha Goyal*; Subodh Agarwal*; S. K. Goyal; Nitin Agarwal*****

*Assistant Professor,
Department of Business Management,
CCS Haryana Agricultural University, Hisar, INDIA

**Professor,
Department of Business Management,
CCS Haryana Agricultural University, Hisar, INDIA
Email id: subodh.agarwal47@gmail.com

***Research Scholar,
Guru Jambeshwar Science & Technology University, Hisar, INDIA

ABSTRACT

A basic assumption in any TS analysis is that some aspects of the past pattern will continue to remain in the future. The most widely used technique for modeling and forecasting the TS data is Box-Jenkins' Autoregressive integrated moving average (ARIMA) methodology. India's exports of agriculture goods will be modeled as ARIMA process. Identification of the values of parameters p,d and q is done on basis of ACF and PACF analysis.The Agricultural Export data was found to be non-stationary and differencing of order one was sufficient for getting an appropriate stationary series. In subsequent sections, we first present the data used and methodology applied for the model building. Next, Agricultural export estimation derived from the fitted models and the related discussions are given accordingly.

KEYWORDS: *ARIMA, Trend, Forecast, Agricultural Export, Box and Jenkins.*

INTRODUCTION

India, with a large and diverse agriculture, is among the world's leading producer of cereals, milk, sugar, fruits and vegetables, spices, eggs and seafood products. Indian agriculture continues to be the backbone of our society and it provides livelihood to nearly 50 per cent of our population. India is supporting 17.84 per cent of world's population, 15% of livestock population with merely 2.4 per cent of world's land and4 per cent water resources. India is currently ranked tenth amongst the major exporters globally as per WTO trade data for 2016. India's share in global exports of agriculture products has increased frommerely1% a few years ago, to 2.2 % in 2016.

Time series (TS) data refers to observations on a variable that occurs in a time sequence. The TS movements of such chronological data can be resolved into trend, periodic (say, seasonal), cyclical and irregular variations. One or two of these components may overshadow the others in some series. A basic assumption in any TS analysis is that some aspects of the past pattern will continue to remain in the future. The most widely used technique for modeling and forecasting the TS data is Box-Jenkins' Autoregressive integrated moving average (ARIMA) methodology.

Thomas et. el.(2011) has explored the growth performance of India's agricultural exports from 1991-92 to 2009-10, Paul et. Al.(2013) has forecast the meat export in India using SARIMA models and Ghose (2017) used ARIMA for forecasting of cotton export in India. In present study, the agricultural export of country has been projected using ARIMA. In subsequent sections, we first present the data used and methodology applied for the model building. Next, Agricultural export estimation derived from the fitted models and the related discussions are given accordingly.

Methodology

Data description and statistical methodology

The time-series data of Agricultural Export from 1990-91 to 2018-19were collected for the purpose from various issues of Economy Survey of India. In accordance with the objective formulated, the statistical analysis was carried out to develop the suitable relationship byARIMA for Agricultural Export prediction in India.

Box –Jenkins autoregressive integrated moving average modeling

The univariate ARIMA approach was first popularized by Box and Jenkins and the models developed through this approach are referred to as univariate Box-Jenkins (UBJ) models. Three stages for univariate ARIMA modelling is identification, parameter estimation, diagnostic checking and forecasting. The general functional form of ARIMA (p,d,q) model is :

$$\phi_p(B)\Delta^d y_t = c + \theta_q(B)a_t$$

where, y = Agricultural Export

B = Lag operator

a = Error term (Y-$\hat{Y}$, where $\hat{Y}$ is the estimated value of Y)

t = time subscript

$\phi_p(B)$ = non-seasonal ARi.e. the autoregressive operator, represented as a polynomial in

the back shift operator

Δ^d= non-seasonal difference

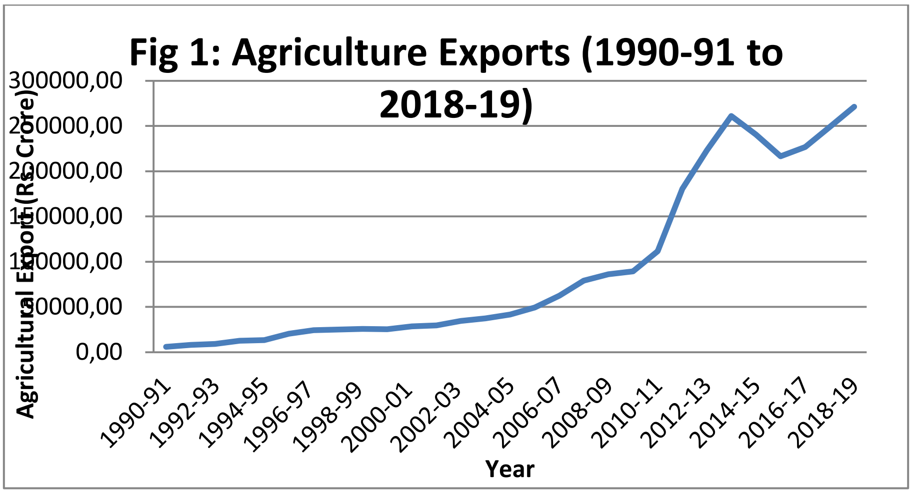
$\theta_q(B)$= non-seasonal MAi.e. the moving-average operator, represented as a polynomial in the back shift operator

ϕ's and θ'$_s$ are the parameters to be estimated

RESULTS AND DISCUSSION

Trends in Agricultural Export

The analysis wascarried out on the time-series data of Agricultural Export ranging from 1990-91 to 2018-19and same is given in Figure-1.A perusal of Figure-1 reveals an increasing trend in the Agricultural export of India over the years. The figure indicates that the export was highest in the year 2013-14. The export after reaching the highest level in 2013-14 declined in next two years 2014-15 and 2105-16. Afterward, it continuously increased.



India's exports of agriculture goods will be modeled as ARIMA process. Identification of the values of parameters p,d and q is done on basis of ACF and PACF analysis.The Agricultural Export data was found to be non-stationary and differencing of order one was sufficient for getting an appropriate stationary series. The estimated ACF are shown in Table-1. After experimenting with different lags of the moving average and autoregressive processes, ARIMA(0,1,1) was fitted for estimating Agricultural export in India. ARIMA(0, d, q) model is also known as exponentially weighted moving average, abbreviated EWMA. EWMA model involves averaging past observations, but the weights applied for recent observations are larger than the weight applied to earlier observations. For this type of data, a forecast emphasizing the last few observations seems more sensible than a forecast emphasizing all past observation equally. Marquardt algorithm (1963)was used to minimize the sum of squared residuals. Log Likelihood, Akaike's Information Criterion, AIC (1969), Schwarz's Bayesian Criterion, SBC (1978) and residual variance decided the criteria to estimate AR and MA coefficients in the model. Parameter estimates of the fitted models are given in Table 2.

TABLE 1 .AUTOCORRELATIONS : AGRICULTURAL EXPORT

			Box-Ljung Statistic		
Lag	Autocorrelation	Std.Error(a)	Value	df	Sig.(b)
1	.896	.176	25.754	1	.000
2	.780	.173	45.992	2	.000
3	.672	.170	61.610	3	.000
4	.577	.167	73.594	4	.000
5	.462	.163	81.575	5	.000
6	.316	.160	85.487	6	.000
7	.182	.156	86.840	7	.000
8	.068	.153	87.035	8	.000
9	.001	.149	87.036	9	.000
10	-.053	.145	87.169	10	.000
11	-.107	.141	87.740	11	.000
12	-.161	.138	89.105	12	.000
13	-.203	.133	91.425	13	.000
14	-.237	.129	94.795	14	.000
15	-.265	.125	99.321	15	.000
16	-.291	.120	105.159	16	.000

The fitted model ARIMA (0,1,1) in algebraic form:

$Y_t = Y_{t-1} - \theta_1 a_{t-1} + a_t$

TABLE 2.PARAMETER ESTIMATES OF ARIMA MODEL

		Estimates	Std Error	t	Approx Sig
Non-Seasonal Lags	MA1	-.526	.168	-3.128	.004
Constant		9550.654	4396.924	2.172	.039

Melard's algorithm was used for estimation.

The residual ACF along with the associated ‘t’ tests and Chi-squared test suggested by Ljung and Box (1978) were used for the checking of random shocks to be white noise (Table 3). The observed and estimated values of Agricultural Export along with their relative deviation are shown in Table 4.

TABLE 3 . DIAGNOSTIC CHECKING OF RESIDUALS AUTOCORRELATIONS: AGRICULTURAL EXPORT

Model	Number of Predictors	Model Fit statistics					
		R-squared	RMSE	MAPE	Normalized BIC	Ljung-Box Q Statistics	Sig.
Agri-export (0,1,1)	0	.974	15451.77	18.25	19.53	9.86	.909

Models	Agricultural Export (1,1,0) (RS. Crore) 2019-20	2020-21	2021-22
Estimate	284973.3	294524.0	304074.7
UCL	316696.8	352402.2	379529.2
LCL	253249.8	236645.8	228620.1

TABLE 4. ACTUAL & FITTED VALUES OFINDIA’S AGRICULTURE EXPORTS (2016-17 TO 2018-19) (RS.CRORE)

Year	Agriculture Exports Actual (Y)	Agriculture Exports Forecast (F)	Relative Deviations
2016-17	226775	220035.4	-2.97
2017-18	249182	239870.6	-3.74
2018-19	271358	263630.4	-2.85

$$\text{Re}\,lativedeviation(RD\%) = \frac{(Estimatedted\ yield - actual\ yield)}{actual\ yield} \times 100$$

TABLE 5. FORECAST VALUES OF AGRICULTURAL EXPORT OF INDIA

UCL & LCL - Upper and lower confidence limits (95%)

ARIMA model could be used successfully for modeling as well as forecasting of yearly export of agricultural products from India. It has been found that there is a significant increasing trend in the Agricultural export from India. The estimated values of agricultural export during 2016-17 to 2018-19 are close to the actual valuesas relative deviation of the estimated and observed figures is in acceptable limits shown in table-4. The level of accuracy achieved by ARIMA (0,1,1) was found adequate for estimating Agricultural Export in India and residuals were white noise. Three-steps ahead (out–of-model development period i.e. 2019-20, 2020-21 and 2021-22) forecasted values of Agricultural export are shown in Table-5.

CONCLUSIONS

Autoregressive integrated moving average (ARIMA) model is used for the purpose. After experimenting with different lags of the moving average and autoregressive processes, ARIMA(0,1,1) was fitted for estimating Agricultural export in India. It was found that estimated values of Agricultural export during 2016-17 to 2018-19 were closed to the actual valuesas percent deviation of the estimated and observed figures were ranging between -2 to -4 and forecasted figures lie within confidence limits based on ARIMA models for the three consecutive years ahead 2019-20, 2020-21 and 2021-22.

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