INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2006/08–4–459–462
http://www. fspublishers.org

An Econometric Model for Forecasting Export of Kinnow from Pakistan

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ABSTRACT

The potential of fruit export in general and Kinnow in particular from Pakistan has never been fully reaped. The export of Kinnow from Pakistan has hitherto been made in the traditional and non-professional manner quite haphazardly. Pakistan is blessed with agro-ecological conditions and enjoys comparative advantage both in the production and export of Kinnow to the market vast in the Middle Eastern countries. The present paper forecasts export of Kinnow up to the year, 2023. The log lin model was applied to estimate past trends in the export of Kinnow. ARIMA model was used to forecast export of Kinnow up to the year 2023. The forecast value of export of Kinnow reveals that there will be an increased demand for Kinnow in the years to come. The paper seeks to suggest measures for increasing production of Kinnow in order to continue to capture major share of Pakistani Kinnow in the global market.

Key Words: Kinnow; Export; ARIMA; Forecast

INTRODUCTION

Pakistan produces and exports a large variety of fruits. Among all fruits, Kinnow enjoys an important position in terms of area, production and exports (Table I). Out of total area under citrus cultivation, about 60% is allocated for Kinnow production (GOP, 2003 - 04). Almost 90% Kinnow produced in Pakistan is exported.

There has been an appreciable growth of citrus industry in this country. The major markets for Pakistani Kinnow are Bahrain, Dubai, Saudi Arabia, Kuwait, Qatar, Oman, UK, Netherlands, Indonesia, Malaysia and Singapore (GOP, 2003). The major export markets for Pakistani Kinnow are mostly the developing countries. Only 2.6% of total Kinnow exported from Pakistan enters the markets of developed countries (Anonymous, 2002).

The present study was undertaken with the following objectives:

1. To estimate growth trends in the Export of Kinnow.
2. To estimate forecasts for the Export of Kinnow from Pakistan.
3. To suggest policy options for boosting exports.

METHODOLOGY

Time series data were used for the present study. The data were collected from various government publications and institutions such as Federal Bureau of Statistics, Ministry of Food, Agriculture and Livestock (MINFAL) and Ministry of Commerce. The data collected, were processed and analyzed using various statistical techniques. Some of the techniques employed for analysis of data are summarized below:

Growth trend. The growth trend for export of Kinnow was estimated using log-linear model. The variables employed in the model were:

X_t = Export of kinnow
X_o = Initial value of export

The compound interest formula used was:

$X_t = X (1 + r)^t$.

Where

r is the compound rate of growth of X, over time. Taking the natural logarithm, the equation was reframed:

β_0 = lnXo
β_1 = ln (1 + r).

The equation was rewritten as:

$LnX_t = \beta_0 + \beta_1 t$.

Adding the disturbance term to above equation we obtained:

$\text{Log } X_I = \beta_0 + \beta_1 t + u_t$.

This equation is known as log-linear model. It is a linear regression model like other linear regression models, because the parameters β_1 and β_2 are linear. The only difference is that regressand is the logarithm of X and the regressor is "time". This model is also called semi log model, because only one variable (in this case the regressand) appears in the logarithmic form. For descriptive purposes a model in which the regressand is logarithmic, will be called a log linear model (Gujarati, 2003).

The growth rate was estimated by taking the anti-log of X_t, i.e.

$X_t = \text{antilog } (\beta_0 + \beta_1 t)$.

Forecast. Forecasts can be estimated by various methods like purely judgmental approaches, structural economic models, univariate time series models, multivariate time series models and econometric models. Economic models require detailed information to specify functional relations among different variables. The functional forms, which

minimize the subjective aspects of model construction, are becoming increasingly popular as a tool of data analysis among economists. Many economists have applied time series models for generating forecasts. Keeping in mind the nature of study, available data, and efficiency of the model to forecast, ARIMA model was selected from amongst the various available time series models for forecasting the export of Kinnow.

A non-seasonal ARIMA model is denoted by ARIMA (p, d, q), according to Box and Jenkins (1976).

Where:

p is the order of the auto regressive process,

d is the order of homogeneity, i.e. the number of differences to make the series stationary,

q is the order of the moving average process.

The general form of ARIMA is:

$$\Delta^d Z_t = C + (\varnothing_1 \Delta^d Z_{t-1} + \ldots + \varnothing_p \Delta^d Z_{t-p}) - (\Phi_1 a_{t-1} + \ldots + \Phi_p a_{t-p}) + a_t.$$

Where

'C' is a constant,

Δ is a difference operator such that

$\Delta Z_t = Z_t - Z_{t-1}$,

$\Delta^2 Z_{t-1} = \Delta Z_t - \Delta Z_{t-1}$

$Z_{t-1} \ldots Z_{t-p}$ are past series values (lags),

$\varnothing$ is the coefficient to be estimated by auto-regressive model.

The auto-regressive model of order 'p' denoted by AR (P) is:

$$Z_t = C + \varnothing_1 Z_{t-1} + \varnothing_2 Z_{t-2} + \ldots + \varnothing_p \Delta^d Z_{t-p} + a_t.$$

Where:

a_t is a random variable with zero mean and constant variance. Φ is coefficient in the moving average (MA) model, whereas moving average model is of order 'q' or MA (q) can be written as:

$$Z_t = a_t - \Phi_1 a_{t-1} - \Phi_2 a_{t-2} - \ldots - \Phi_p a_{t-p}.$$

The above model was employed for analyzing the quantitative relationship of data and to forecast future trend of Kinnow export up to the year, 2023.

RESULTS AND DISCUSSIONS

Growth trends in the export of kinnow. The equation used for estimating growth rate is:

$$\text{Ln } X_t = \beta_o + \beta_1 t$$

Where:

X_t = Export

t = Time.

Regression was run on the time series data of export of Kinnow. The estimated equation is given as:

X_t	=	9.860 + 0.04706 t
S.E.		(0.189) (0.014)
t		(52.223) (3.273)
R^2		0.349.

In this model β_1, the slope coefficient, measures relative change in X for a given change in the value of the regressor (in this case the variable ("t"), that is:

$$\beta_1 = \frac{\text{Relative change in regressand } (X_t)}{\text{Absolute change in regressor (t)}}$$

By multiplying the relative change in X_t by 100, we obtain % age change or growth rate in X for an absolute change in t, the regressor.

Relative change is:

β_1	=	0.0471
Growth rate	=	β_1. 100
Growth rate	=	0.0471 x 100
Growth rate	=	4.71 %.

The above results illustrate that over the period, 1982 - 2002, export of Kinnow increased at the rate of 2.874% per annum.

The growth rate worked out is an instantaneous (at a point in time) rate of growth and not the compound (over period of time) rate of growth. Compound growth rate (r) can be estimated from the instantaneous rate of growth, in that:

Instantaneous growth rate = 0.0471

We know that Ln (1 + r) = β_1 (As discussed in methodology).

Ln (I + r) = β_1

r = Anti ln β_1 – 1

Compound rate of growth = r = 4.818%

The instantaneous growth rate for export of Kinnow is 4.706%, which shows that over the period, 1982 – 2002, export of Kinnow grew at the rate of 4.706% per year. The compound rate of growth for export was estimated as 4.818%.

Reliability of results. Very low value of the S.E. of coefficients indicates lesser variability in the data set. Estimated value of t test describes that coefficients are statistically significant at 1% significance level. Similarly value of R^2 (0.349), shows that 34.9% regressand (export) was explained by the regressor (time period). The results confirm reliability of the estimated values.

Forecasting export of kinnow. Using time series data, ARIMA model was applied in four steps (Box & Jenkins, 1970) for the purpose of forecasting. These steps are as follows:

a) Model Identification: It was the specification of p, d, q.

b) Model estimation: It consisted of estimated parameters.

c) Diagnostic checking: It consisted application of a variety of tests to see whether the estimated model fit the data.

d) Forecasts: Forecasts obtained at 95% confidence interval with lower and upper limits.

Model identification. Differenced time series and the auto correlation function of the differenced series were taken. Correlogram of first differenced series of the auto-correlation function showed properties of the stationary series. To check further stationarity, second differenced time

Table I. Area and Export of Citrus

Year	Area (000' hectares)	% Age change	Export (000' tons)	Export Value (million Rs.)
1990-91	173.3	-	112	935
1991-92	176.2	1.673	125	966
1992-93	176.2	-	121	1179
1993-94	185.0	4.994	127	1324
1994-95	190.7	3.081	139	1256
1995-96	193.6	1.1521	135	1487
1996-97	194.4	0.413	219	2776
1997-98	196.1	0.874	202	2793
1998-99	197.0	0.458	181	2773
1999-00	197.7	0.355	240	4130
2000-01	198.7	0.506	260	4586
2001-02	194.2	-	216	3958

Source: Federal Bureau of Statistics (2001-02)

series were also observed. Correlogram of the second differenced series showed appropriate stationary behaviour than the first differenced series. Auto correlation function fell as quickly as the lag K increased. Thus the selected value of "d" was 2. The selected value of parameters "p" and "q" was 2 and 2, respectively. After the determination of parameters p, d, q, appropriate model estimated was ARIMA (2, 2, 2).

Model estimation. The model ARIMS (2, 2, 2), was estimated using the E-view computer programme. The estimated parameters are presented in Table II.

Augmented Dickey - Fuller unit root test on time series data of export was applied. Following results were obtained:

ADF – Test statistic = -2.105817 1% critical Value = -3.8304.

5% critical Value = -3.8304 10% critical Value = -3.8304.

As the absolute value of ADF test-statistic was greater than the critical values at 10% level of significance, time series was stationary for the ARIMA (2, 2, 2). Hence, ARIMA (2, 2, 2), was found as the best fit (Table III).

Forecast for the export quantity of 'kinnow'. Forecasts for the years up to 2023 were estimated at 95% confidence intervals, using ARIMA (2, 2, 2). Forecasts with their upper and Lower Limits at 95% confidence interval are given in Table IV. It is quite evident from the table that quantity of export of Kinnow will increase in future. As such, available quantity of export will be 142691 tons in 2002-03, with a minimum export of 106004 tons and with a maximum export of 179379.00 tons. In the year, 2022-23, Kinnow export will attain a level of 2.04466×10^6 tons.

Suggestions. Pakistan has much potential in the export of Kinnow to the vast market in the Middle Eastern countries and south East Asia. Given an increased production of Kinnow in the country in future, much potential exists for its export in the global market, as estimated. There is therefore dire need that the government undertakes activities for developing infrastructure, keeping in view the future production scenario of Kinnow in Pakistan. Government should offer incentives to the concerned stakeholders for the growth and promotion of input industry required for Kinnow production and also to the allied packaging, processing, transportation and storage industries. A well-integrated allied network would guarantee a prosperous future for Kinnow exports.

There is also an urgent need to start a campaign for boosting exports of Kinnow. The right strategy in this

Table II. Estimates of the parameters

Parameter	Estimates	S. E.	t ratio	P value
AR (1)	0.154667	0.291805	0.530034	0.603846
AR (2)	-0.299391	0.240627	-1.24421	0.232514
MA (1)	1.3049	0.159301	8.19142	0.000001
MA (2)	-0.863518	0.134684	-6.41142	0.000012
Mean	1220.5	1874.74	0.651024	0.524880
Content	1397.13			

Table III. Augmented Dickey-Fuller Unit Root Test on Export

ADF Test Statistic	**-5.38304**	**1%**	**Critical Value***	**-3.857**
		5%	**Critical Value**	**-3.04**
		10%	**Critical Value**	**-2.661**

* MacKinnon critical values for rejection of hypothesis of a unit root

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(EXPORT_QT_01,3)

Method: Least Squares

Variable	Coefficient	Std. Error	T-Statistic	Prob
D(EXPORT_QT_01 (-1), 2)	-2.25704	0.419287	-5.38304	0.0001
D(EXPORT_QT_01 (-1), 3)	0.429124	0.248464	1.727109	0.1047
C	-3005.179	4368.008	0.687998	0.502
R-square	.833217	Mean dependent var.		-247.9
Adjusted R-Square	.810979	S.D dependent var.		42458
S.E. of Regression	18459.16	Akaike info criterion		22.636
Sum Squared Residual.	5.11E+09	Schwarz criterion		22.784
Log likelihood	-200.7197	F-statistic		37.469
Durbin-Watson Stat	2.179015	Prob. (F-statistic)		0.000001

Table IV. Forecasts for the Export of Kinnow

No.	Year	Forecasts (tons)	Lower Limit	95% Upper 95% Limit
1.	2002-03	142691	106004	179379
2.	2003-04	183435	135291	231580
3.	2004-05	229727	167241	292214
4.	2005-06	272363	183405	361322
5.	2006-07	314170	191234	437106
6.	2007-08	358340	198825	517855
7.	2009-10	404521	205933	603110
8.	2010-11	451703	210823	692583
9.	2011-12	499834	213593	786076
10,	2012-13	549210	214981	883440
11.	2013-14	599891	215263	984520
12.	2014-15	651799	214426	1.08917×10^6
13.	2015-16	704903	212519	1.19729×10^6
14.	2016-17	759221	209665	1.30878×10^6
15.	2017-18	814767	205967	1.42357×10^6
16.	2018-19	871536	201489	1.54158×10^6
17.	2019-20	929523	196292	1.60275×10^6
18.	2020-21	988731	190434	1.78703×10^6
19.	2021-22	1.04916×10^6	183970	1.91435×10^6
20.	2022-23	1.11081×10^6	176950	2.04466×10^6

respect is to identify new markets with diversification of existing product portfolio. In this context, Pakistan should promote a culture of value addition. This strategy will enhance total receipts form the exports of Kinnow. Policy measures are needed for coping with the changing environment under upcoming WTO regime. There is need to modernize and up-date existing production, harvesting and post harvest management practices. Moreover, measures must bet taken for ensuring authenticity of certification for boosting exports. Packaging of Kinnow is an important aspect and packaging industry should be assigned a priority. Above all, a campaign should be launched to build good image of Pakistani Kinnow in the international market.

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(Received 19 January 2006; Accepted 20 March 2006)