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Forecasting Export Prices of Sri Lankan Coconut Products Using Multivariate Time series.

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Abstract Sri Lanka is popular for coconut products in the world market. Coconut oil, nuts, fiber and desiccated coconuts (DC) are the most worth export items. The fluctuations in the prices of coconut exports making a great risk of investing, buffer stock maintaining, international trade and other associated actions. Thus, it is vital to forecast future prices for decision-making purposes. Our objective is to forecast the average monthly prices of selected three products viz. desiccated coconut (DC), oil and nuts.

In this study, we consider monthly average export prices of DC, oil and nuts from January 2007 from December 2016. Thus, each series consists of 120 data points. There were some missing values in coconut nut prices after that estimated those values by using *ARIMA (1,2,1)*. First 114 data points are used to build the model and remaining six data points are used to validate the forecasting model. To select the best model, selection criteria based on the Akaike information criterion (AIC), Hannan– Quinn information criterion (HQIC) and Bayes information criterion (BIC) are used. Out of all competing models, we observe that the best model for the DC prices is ARIMA (2,2,1), Oil price is SARIMA (0, 1, 1) (0,0,1) [12] and for coconut nuts prices is ARIMA (1,1,0). Then, the testing data set is used to validate the prediction.

Since there is a strong correlation between prices, we consider vector auto regression (VAR) model to improve the forecasts. Among several plausible models VAR of order 3 results in the best model. VAR (3) model shows that the prices of coconut nuts have a strong relationship among DC and oil prices. DC prices are independent of oil and nut prices as well as oil prices depend on DC and do not depend on prices of Nuts. VAR models provide better forecasts for prices of nuts and oil.

Keywords*: **ARIMA, VAR, time series, Cross correlation***

1.0 Introduction

Coconut has been the third most important commercial crop of Sri Lanka since the colonial era. Sri Lanka is the world's fourth largest producer of coconut, covering a total acreage of 394836ha. In 2016, its contribution to the Gross Domestic Product (GDP) was 1.2 % while agricultural contribution to the GDP was 17.9 % (Central Bank of Sri Lanka,2007). The average annual coconut production is around 2500 million nuts, of which around 65% is used for household consumption. Coconut oil, coconut nuts, coconut fiber and desiccated coconuts(DC) are the most powerful export items in the Sri Lanka. Sri Lankan DC has ranked Sri Lanka at the 4th position of world export market for all kernel products.

Among the coconut exporters the former is export oriented, and the latter caters mainly to the domestic market. Coconut products may deal with a number of prices in the market channels: such as retail prices, wholesale prices, auction prices, FOB (Free On Board) prices, CIF prices (costs and freight includes insurance). All these prices are undergone to fluctuation making a great risk of investing, buffer stock maintaining,

making future contracts, and in international trade and other associated actions. One common and powerful tool to overcome above problems is prediction of future prices and develop scientific forecasting model.

2.0 Significance of the study

This study focused on find a suitable model for the forecasting export prices of coconut product using various methods. Also we can found the interrelationship between each and every variable. It helps to determine whether prices movements are spread instantaneously to other markets or long term effect to other markets. This study is also expose the interrelationship between these important plantation products and their returns on the GDP of the Sri Lankan economy.

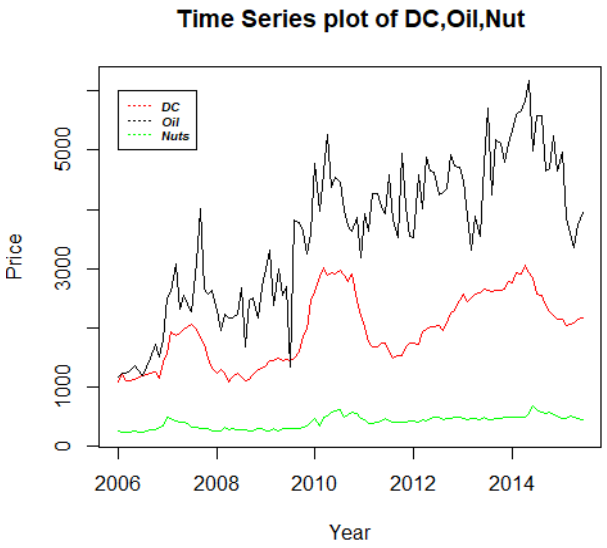

Figure_1: Time series plot of DC, Oil, Nuts

3.0 Methodology

This study used export prices reported the Coconut Development Authority (CDA). The data was available on average monthly export prices of DC, Oil and Nuts including over a decade (2007-2016). The DC and oil data were measured by rupees per metric ton and nuts was measured by rupees per 1000 nuts.

Each and every set divided into two sets, which used to formulate appropriate model and forecasting evaluation process. Testing set was used to get accurate measurements of formulated model. Time Series (TS) plots used to find the major behavioral and patterns against the time. When the preliminary data extracted from the TS plots, the data were checked for the stationary. If the data series shows a non-stationary pattern, the first order differencing method was used as the first attempt to convert it into a stationary series. If the data series was not achieved by the stationary after taking first differences, it was transformed using log transformation method and then found first order differences.

The series of transformed data were analyzed using six standard time series methods; viz; ARIMA, SARIMA and Exponential smoothing.

4.0 Results and Discussion

In this section, we discuss the missing value estimation using univariate time series model.

4.1 Missing value estimation

According to data, there are 4 missing values has occurred in the 1st quarter of year 2015.In order to estimate missing values, an appropriate model is fitted for first 96 observations.

Firstly, ADF, KPSS and PP test use to check whether the series stationery or not. After that log transformed 2nd difference data were stationery and after compared various types of models, found the ARIMA (1,2,1) is the best model for the estimate the missing values.

4.2 Model for Coconut Nuts, DC, Oil

After imputing missing values, we develop a model for coconut nuts by considering the various type of models. Finally, ARIMA (1,1,0) was selected for the best model by considering model evaluation and diagnostic checking.

Stationery tests provide that 2nd difference of data were stationery for the DC prices, and found ARIMA (2,2,1) as the best model after comparing the different types of models.

ACF plot of coconut oil shows the very weakly seasonal pattern over every 12 months. Therefore, after considering the various types of ARIMA and SARIMA models, found the SARIMA (0,1,1) (0,0,1) [12] model with good accuracy.

Table_1: Model for all variables

Type	Model
Dc	ARIMA (2,2,1)
Oil	SARIMA (0,1,1) (0,0,1) [12]
Nuts	ARIMA (1,1,0)

4.3 VAR model

After testing cointegration test (Johansen, 1988), we obtained there is no cointegration among those 3 variables. Therefore, VAR (3) model has been selecting for forecasting process, and after that we moved to check dependencies among variables.

Table_2: Estimates for DC as a dependent variable

	Significant Estimate
DC lag1	1.18625
DC lag 3	-0.34950
Constant	87.60170

Dc prices depend on their own past lags. That represents linear independency of desiccated coconut export prices.

Table_3: Estimates for Oil as a dependent variable

	Significant Estimate
DC lag1	1.50904
Oil lag1	0.456630
DC lag2	-1.77046
Oil lag3	0.18734

Oil prices depend on their own DC and their own lags. That represents linear dependency of oil which represents oil prices are depend with monthly export prices of DC.

Table_4: Estimates for Nuts as a dependent variable

	Significant Estimate
DC lag1	0.094051
Nuts lag1	0.598272
DC lag2	-0.084607
Oil lag2	0.013428
const	34.889462

Oil prices depend on their own DC and their own lags. That represents linear dependency of oil which represents oil prices are depend with monthly export prices of DC.

5.0 Conclusion

The coefficient estimates between Oil and Nuts are not the same as between Nuts and Oil at all lags, between DC and Oil, as well as between DC and Nuts. This indicates that there is a feedback relationship between the three series. Also oil and nut prices has depended with DC prices.

We can conclude that the price movement of one market can spread easily and instantly to another

market and also there is a fairly strong correlation between the prices of the assets. Therefore, financial export markets are more or less dependent on each other; hence there is an interrelationship between variables. Among all individual forecasting models tested, the ARIMA, SARIMA and VAR as a multivariate model were found better than other models to predict prices of coconut and coconut products in Sri Lanka as they have the lowest MAPE, MAE and RMSE.

6.0 References

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