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SEASONAL VARIATIONS IN RETAIL AND WHOLESALE PRICES OF RICE IN COLOMBO MARKETS, SRI LANKA

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The prices in agricultural markets are determined through interaction between the demand and supply forces. The study of price movements at different market levels and the impact of different institutions such as co-operatives, futures contract, vertical integration, etc., are important in determining the government policy directions in price regulation mechanisms and changes in market levels. In less developed countries such as Sri Lanka, inflation raises several doubts regarding the possibility of measuring the real impacts of the demand and supply forces on market prices. Inflation has an additional effect on the agricultural stocks that are held by the farmers. They may hold these reserve stocks for longer periods in anticipation of price increase. These stocks may be released to the markets in the off season, thus influencing a seasonal price movement at retail and wholesale, markets. The influence of factors such as changes in government policies, civil strifes, may distort accurate estimation and contribute to sources of error to the price analysis of agricultural markets at different market levels. The previous studies done by Hill and Insergent (1977) on the margins of retail and farm prices assumed constant absolute margin of the product, perfect competition in the retail and wholesale markets, and constant costs in the processing industry. Dahl and Hammond (1977) indicated that farm and retail price movements follow a parallel path in time. Shepherd (1963) has, however, denied such parallel relations in the retail and farm prices. The existence of factors such as seasonality, perishability, speculation of agricultural products gives a distinct character for each market level. Barr and Gale (1973) applied econometric models for single crop, livestock products. However, Granger and Newbold (1977) exposed the limitations in such econometric studies. Rausser and Cargill (1970), Parikh (1971), Weiss (1970), Kulshreshtha and Wilson (1974) introduced applied spectral analysis of agricultural products. Earlier studies done by Lakshminarayan *et al.* (1977) and Revell (1974) used Box and Jenkins applications.

The main objective of this study is to investigate the retail and wholesale prices of rice in Colombo markets, Sri Lanka. Further, it examines the appropriateness of a forecasting procedure based on the Box-Jenkins ARIMA method for the retail and wholesale prices of rice in this market.

DATA COLLECTION

Since 1979, the Market Research and Food Policy Division of the Agrarian Research and Training Institute, Colombo collects weekly retail price data from

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parameters of the identified model are substituted by the maximum likelihood method. The diagnostic checks are then carried out until a suitable representation is obtained.

The representation of a transfer function between X_t and Y_t is given by,

$$Y_t = V(B) X_t + U_t$$

where

$V(B)$ = transfer function approximated by the ratio of the two polynomial operators;

U_t = noise process that follows a univariate ARIMA process.

RESULTS AND DISCUSSION

The deflated retail and wholesale price data reflect the non-monetary influences on prices and the seasonal patterns and price level fluctuations tend to emerge from such data. A twelve-month moving average of the monthly spot prices for rice was computed and the ratios of the original monthly prices to the corresponding averages were formed. These ratios measure the monthly deviations from the average. The average of these ratios was calculated for each month of the full time-series to arrive at a seasonal price index for each month (Table I). The seasonal low retail (wholesale) price index in March/April (March) and September/October (June, July) respectively reflects the arrival of the wet season and dry season harvests in the retail (wholesale) markets. The peak retail (wholesale) price index occurs in December/January (December). This indicates that the dry season crop is not large enough to cause a decline in the retail (wholesale) price for a longer period as that of the wet season crop. The seasonal retail (wholesale) price increases were highest in January and December (November, December) respectively. Such price increases at the retail (wholesale) market reflect the escalation of costs of other marketing services, *e.g.*, storage, bagging, transportation, handling and processing charges.

Retail Price of Rice

Table II shows the lag, autocorrelation coefficients (acf), partial autocorrelation (pacf) coefficients and the standard errors for retail price of rice after differencing and after removal of yearly trend. From the original data, the acf of one to twelve lags are significantly different from zero and the existence of a trend could be easily seen. In general, the acf are large and positive until the random errors dominate such coefficients. The result indicates that the retail price data series is not stationary.

The range mean plot of the series indicates the need for the logarithm of the data. The logarithmic form of the series was taken to increase its variances. To remove the non-stationary nature of the retail price data, differencing was done. The acf and pacf drop to zero after the first lag. The acf and pacf of orders 4, 5 and 12 are

TABLE I. SEASONAL RETAIL PRICE INDEX IN COLOMBO MARKETS

Month	Price index for rice		Seasonal increases in price index for rice	
	Retail	Wholesale	Retail	Wholesale
January	111.2	106.7	20.0	20.6
February	104.3	104.2	12.5	17.8
March	94.9	88.5	2.4	0.0
April	94.7	87.6	2.0	1.0
May	96.0	91.2	3.5	3.1
June	96.3	95.3	3.9	7.7
July	98.9	96.2	6.7	8.7
August	99.1	96.8	6.9	9.4
September	92.7	96.9	0.0	9.5
October	96.8	107.9	4.2	21.9
November	108.0	111.4	16.5	25.6
December	110.6	113.4	19.3	28.1

Note:— The seasonal increase of retail and wholesale price was computed as a percentage value of the lowest month.

significantly different from zero. The result exhibits a mixture of non-stationary, seasonal (AR or MA) patterns of the data after differencing.

The data was further subjected to a method of differencing for the removal of the yearly trends. The acf and pacf values drop to zero after the second lag. Similarly, the acf of orders 4 and 9 and pacf of orders 4, 8 and 9 are significantly different from zero.

Table III shows the ARIMA results for retail price of rice. The estimated results are presented with their standard errors. The optimum values of the moving averages are obtained after four iterations. The SMA parameter is significantly different from zero but not the MA parameter. However, the estimated coefficents are relatively stable as represented by their low standard errors.

Table IV shows the nine-month ahead forecasts based on ARIMA procedure on 108 known observations of the retail price of rice. These values are observed with the actual retail price of rice for the first nine months in 1985. The actual retail price closely resembles the forecasts with a variation of 0.09 cent in September to 0.02 cent in February.

TABLE II. AUTOCORRELATIONS OF RETAIL PRICE OF RICE

	Original data		After differencing		After removal of yearly trend	
	acf	pacf	acf	pacf	acf	pacf
1	0.943 (0.096)	0.943 (0.096)	−0.090 (0.097)	−0.090 (0.097)	0.069 (0.101)	0.069 (0.101)
2	0.901 (0.160)	0.113 (0.096)	−0.135 (0.097)	−0.144 (0.097)	−0.179 (0.101)	−0.185 (0.101)
3	0.871 (0.202)	−0.010 (0.096)	0.047 (0.099)	0.020 (0.097)	−0.156 (0.105)	−0.134 (0.101)
4	0.837 (0.237)	0.124 (0.096)	−0.270 (0.099)	−0.292 (0.097)	−0.321 (0.107)	−0.354 (0.101)
5	0.819 (0.260)	−0.051 (0.096)	0.092 (0.106)	0.053 (0.097)	0.179 (0.116)	0.180 (0.101)
6	0.792 (0.283)	−0.028 (0.096)	0.088 (0.107)	0.014 (0.097)	0.161 (0.119)	−0.010 (0.101)
7	0.762 (0.303)	0.015 (0.096)	−0.074 (0.107)	−0.032 (0.097)	−0.036 (0.121)	−0.069 (0.101)
8	0.737 (0.320)	0.146 (0.096)	−0.270 (0.108)	−0.384 (0.097)	−0.211 (0.122)	−0.307 (0.101)
9	0.727 (0.336)	0.030 (0.096)	−0.015 (0.114)	−0.061 (0.097)	−0.467 (0.142)	−0.452 (0.101)
10	0.718 (0.350)	0.029 (0.096)	−0.038 (0.114)	−0.165 (0.097)	−0.028 (0.142)	−0.190 (0.101)
11	0.708 (0.363)	−0.004 (0.096)	0.108 (0.114)	0.072 (0.097)	0.339 (0.150)	0.070 (0.101)
12	0.696 (0.376)	−0.133 (0.096)	0.292 (0.115)	0.111 (0.097)	0.297 (0.150)	0.097 (0.101)
Mean	0.010		0.004		0.004	
Standard deviation	0.093		0.131		0.131	
n	108		108		108	

Note:— acf refers to autocorrelation coefficients; pacf refers to partial autocorrelations; values in parentheses are standard deviations.

TABLE III. ARIMA RESULTS FOR RETAIL PRICE OF RICE

Iterations	Parameter values	
	Moving average (MA)	Seasonal moving average (SMA)
0	0.100	0.100
1	0.051	0.303
2	0.146	0.331
3	0.157	0.337
4	0.152	0.338
	(0.169)	(0.121)

Figures in parentheses are standard errors.

TABLE IV. FORECAST VALUES FOR RETAIL PRICE OF RICE FOR 1985

Month	Forecast values of retail prices (Rs./kg.)	Actual retail prices (without deflation(Rs./kg.)	Error margin (Rs./kg.)
1984			
November	–	9.43	–
December	–	11.58	–
1985			
January	12.36	12.39	0.03
February	12.69	12.67	−0.02
March	12.50	12.53	0.03
April	11.42	11.49	0.07
May	11.16	11.09	−0.07
June	11.96	11.99	0.03
July	12.07	12.01	−0.06
August	12.00	11.98	−0.02
September	11.22	11.31	0.09

Wholesale Price of Rice

The autocorrelation coefficients (acf) for the wholesale price of rice from one to seven lags are significantly different from zero (Table V). As in the case of retail price of rice, there was initially a negative and then a positive trend in the series of wholesale price data. The patterns of the data indicated that the series were not stationary as in the retail prices. In order to obtain a stationary data series the

TABLE V. AUTOCORRELATION OF WHOLESALE PRICE OF PRICE

Lag	Original data		After differencing		After removal of yearly trend	
	acf	pacf	acf	pacf	acf	pacf
1	0.820 (0.164)	0.820 (0.164)	0.311 (0.167)	0.311 (0.167)	0.284 (0.174)	0.284 (0.174)
2	0.504 (0.252)	0.510 (0.164)	−0.169 (0.182)	−0.183 (0.167)	−0.118 (0.188)	−0.216 (0.174)
3	0.238 (0.278)	0.129 (0.164)	−0.345 (0.183)	−0.301 (0.167)	−0.517 (0.190)	−0.474 (0.174)
4	0.102 (0.283)	0.101 (0.164)	−0.154 (0.200)	−0.053 (0.167)	−0.143 (0.229)	−0.164 (0.174)
5	0.045 (0.284)	0.104 (0.164)	−0.123 (0.203)	−0.170 (0.167)	−0.003 (0.231)	−0.131 (0.174)
6	0.102 (0.284)	0.105 (0.164)	−0.035 (0.206)	−0.085 (0.167)	0.097 (0.231)	−0.193 (0.174)
7	0.017 (0.284)	0.008 (0.164)	−0.178 (0.206)	−0.243 (0.167)	−0.049 (0.233)	−0.041 (0.174)
8	0.007 (0.284)	0.179 (0.164)	−0.205 (0.210)	−0.065 (0.167)	−0.074 (0.233)	−0.121 (0.174)
9	0.100 (0.284)	0.118 (0.164)	−0.068 (0.215)	−0.065 (0.167)	−0.182 (0.234)	−0.305 (0.174)
10	0.217 (0.285)	0.052 (0.164)	0.076 (0.216)	−0.161 (0.167)	−0.090 (0.238)	−0.147 (0.174)
11	0.281 (0.290)	−0.012 (0.164)	0.085 (0.217)	−0.195 (0.167)	−0.018 (0.239)	−0.088 (0.174)
12	0.304 (0.297)	0.167 (0.164)	0.294 (0.218)	0.222 (0.167)	−0.229 (0.239)	−0.043 (0.174)
Mean	0.005		0.005		0.004	
Standard deviation	0.094		0.079		0.121	

Note:— acf refers to autocorrelation; pacf refers to partial atuocorrelations; values in parentheses are the standard deviations.

method of first difference was used after converting the series to the logarithmic form. The acf and pacf were not significantly different from zero after the second lag. The differencing was further extended to remove the trend of the series. The optimal values for ARIMA for wholesale price of rice were obtained after six iterations. The moving averages were significantly different from zero and the low standard errors indicated a relatively stable nature of the results (Table VI).

TABLE VI. FORECAST VALUES FOR WHOLESALE PRICE OF RICE FOR 1985

Month	Forecast values (Rs./kg.)	Actual wholesale price (Rs./kg.)	Error (Rs./kg.)
1984			
November	–	8.28	–
December	–	9.20	–
1985			
January	9.85	9.57	−0.28
February	9.79	9.26	−0.53
March	9.67	9.14	−0.53
April	9.38	8.99	−0.39
May	10.12	9.89	−0.23
June	10.27	10.12	−0.15
July	11.03	10.89	−0.14
August	10.92	10.86	−0.06
September	9.81	9.77	−0.04

To study the relationship between the retail and wholesale prices the cross correlation function(ccf) was constructed between the residuals of the data series (Haugh and Box, 1977). The ccf represents causality direction in Granger's sense between retail prices at time t and wholesale prices at time t+k (k =.....−2,−1,0,1,2,....). The result indicates a correlation between retail and wholesale prices; and the influence of retail prices in t on wholesale prices of t+1,t+2,t+3....etc. Hence, the effect of retail prices on wholesale prices may show up within one month; and the retail prices of any month may have a clear impact on the wholesale price of rice in the following months.

CONCLUSIONS

The univariate analysis for both series shows that the retail and wholesale prices of rice in Colombo markets have different structures in economic terms. Both retail and wholesale market prices exhibit seasonality in prices. However, this is more prominent in the retail than in wholesale prices. The response to ARIMA is different

in the two price series. The results indicated that the forecast values are over-estimates when compared with the actual. Ignoring the seasonality, the retail prices show that the past price history provides no improvements in forecasting future price changes. The interaction between retail and wholesale prices and the influence of current retail price on wholesale prices of t+1, t+2, t+3,...are significant features of the results. This means that any increase in the supply of rice due to retail price in t will arrive in the market at t+3, thus preventing any further increase in price. In this study the development of a transfer function was not possible due to the short time-series available for wholesale price of rice.

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