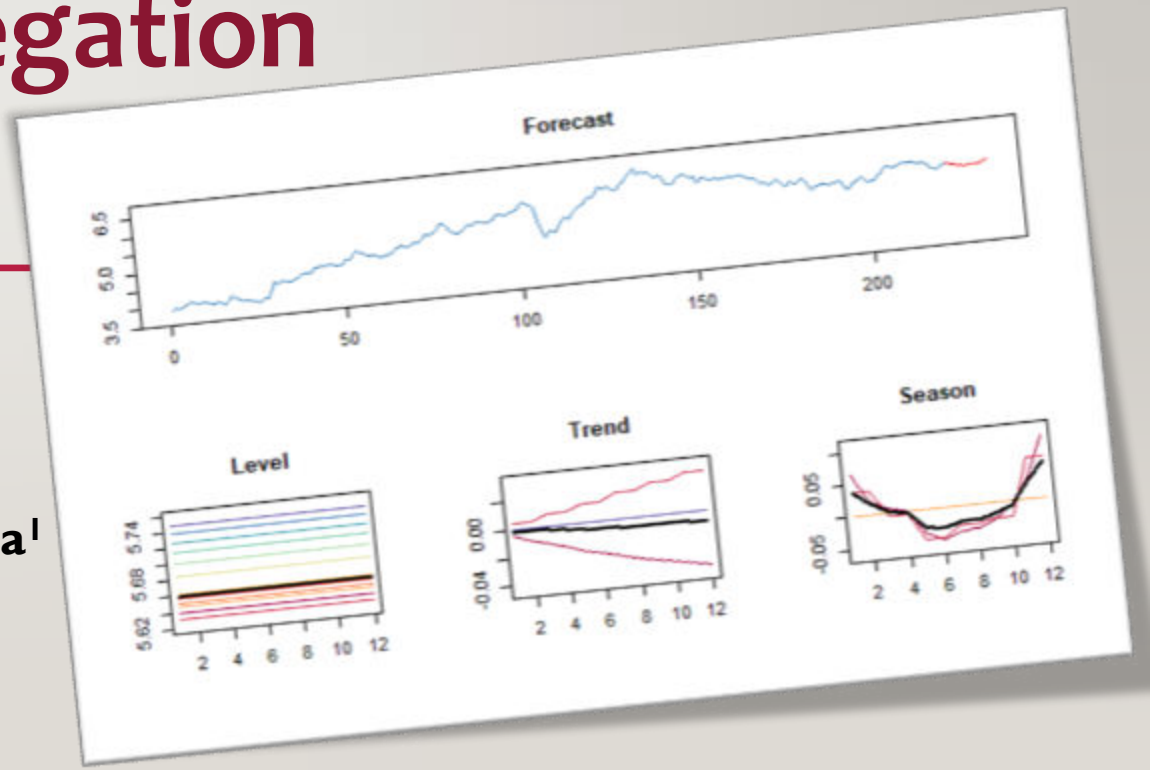
Forecasting of Rubber Prices in the Sri Lankan Market Using Multiple Temporal Aggregation (MTA)



Wasana Wijesuriya[1], HMLK Herath[2], PGN Ishani[1], JKS Sankalpa[1]
1- Rubber Research Institute of Sri Lanka
2- Wayamba University of Sri Lanka

BACKGROUND

- Agricultural commodities are subjected to noticeable price fluctuations
- NR is not an exception
- The volatility of NR prices has been a significant risk to producers, traders, consumers and others involved in the production and marketing in NR
- In situations of substantial uncertainty and high risks, price forecasts have become necessary for decision-making

SOME METHODS…

- ARIMA (Auto-Regressive Integrated Moving Average) models
- Daud (1983), Shamsudin and Fathima (1990), Romprasert (2009) and Chinye and Mesike (2012) - forecasting efficiencies were found to be better compared to the conventional smoothing time series techniques

SOME METHODS…

- Wijesuriya and Thattil (1997) - seasonal ARIMA (SARIMA) models are not adequate for tracking the true price generating mechanism
- Later Herath *et al.* (2013) have found that Exponential GARCH (EGARCH) is a promising model that correctly generates price returns of RSS-1

NEW TRENDS IN FORECASTING

AUTOMATIC FORECASTING ALGORITHMS ……..

Motivation

- Common in business to have over 1000 products that need forecasting at least monthly.
- Forecasts are often required by people who are untrained in time series analysis.

Rob J Hyndman

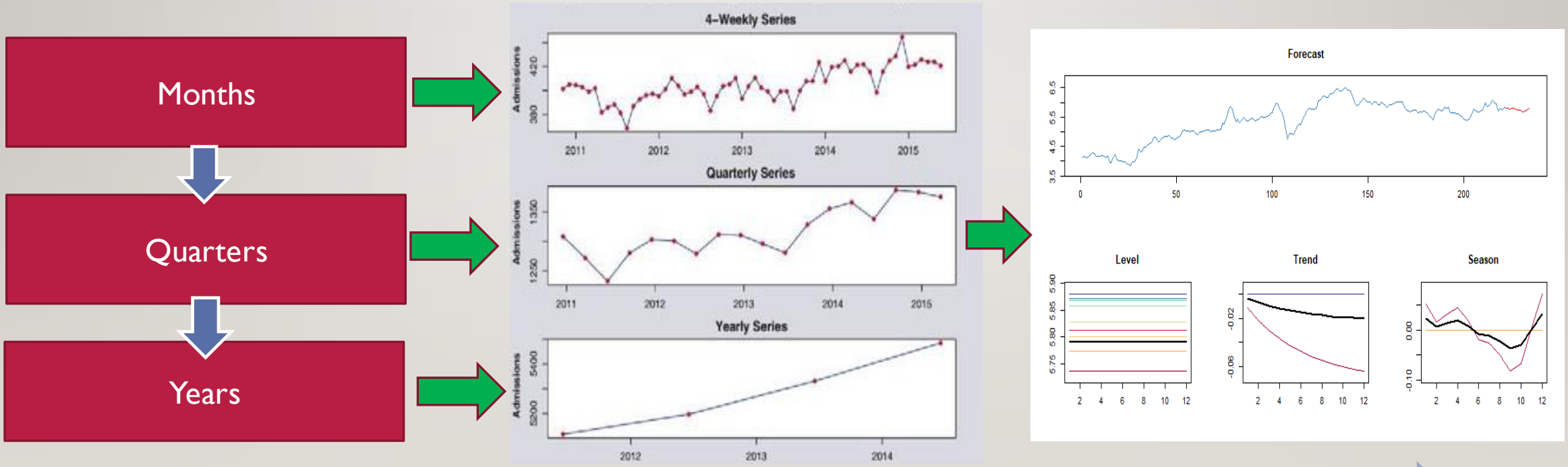
OBJECTIVE OF THIS STUDY …

- Introduce Multiple Temporal Aggregation (MTA) into automatic forecasting algorithms
- Compare the forecasts from ARIMA and Exponential Smoothing (ETS) with forecasts from Multiple Aggregation Prediction Algorithm (MAPA)

What is Multiple Temporal Aggregation ?

- Model selection - a tedious procedure and requires considerable skill in time series analysis
- Kourentzes, N., Petropoulos, F. and Trapero, J.R. (2014) - proposed a solution by introducing temporal aggregation and forecast combination
- Mitigates the issue of model selection, while improving the forecast accuracy

What is Multiple Temporal Aggregation ?



Aggregation

Forecasting

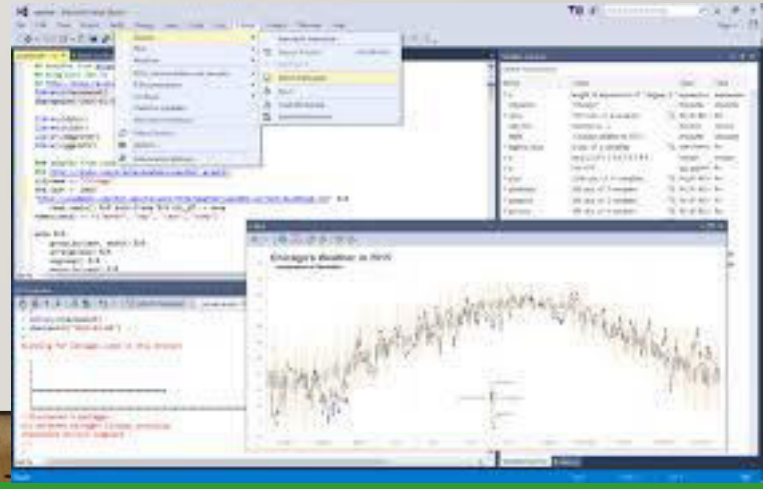
Combination

METHODOLOGY - DATA

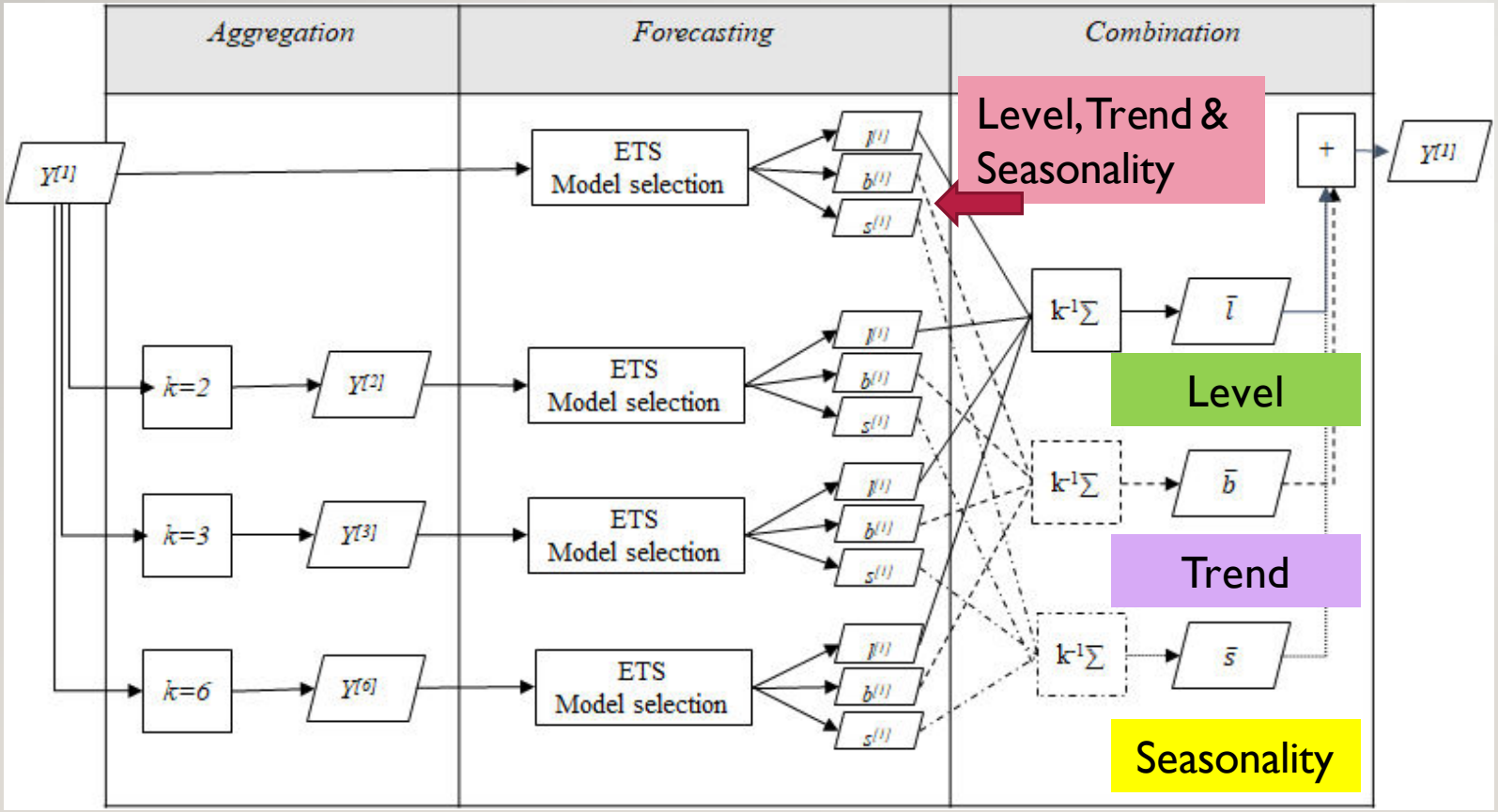
- Rubber prices in the auction at Colombo Sri Lanka - usually two auctions are held in a week
- Average monthly auction prices of LC-1 and RSS-1
- Period considered – January 2000 to June 2019
- January 2000 to June 2018 - used for estimation of models
- July 2018 to June 2019 (12 months) – used for forecast validation
- Prices as Log values - to get rid of increased variability with time in prices of both rubber grades

ESTIMATION AND FORECASTING PROCESS

- **Methods used:**
  - Holt Winters Exponential smoothing (ETS) and seasonal ARIMA (SARIMA) as conventional time series techniques
  - Multiple Aggregation Prediction Algorithm (MAPA) package in R developed by Kourentzes *et al.*, (2014)
- **Software used: R Studio**



MULTIPLE AGGREGATION PREDICTION ALGORITHM (MAPA)

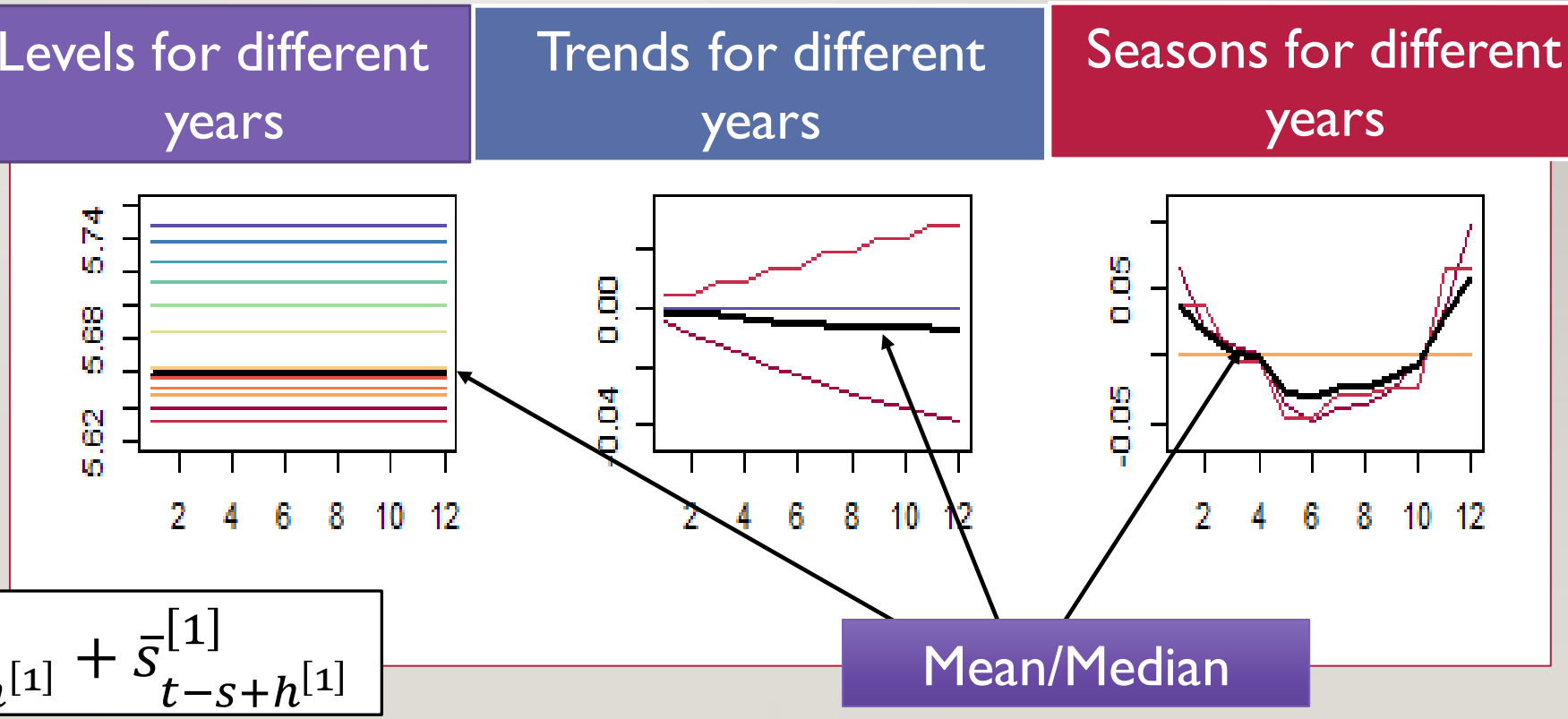


Stage 1: Aggregation - non-overlapping means of length *k* – *2, 3, 6, 12*

Stage 2: Forecasting – Level, Trend & Seasonality for aggregation levels

MULTIPLE AGGREGATION PREDICTION ALGORITHM (MAPA)

Stage 3: Combination – Adding the Level, Trend & Seasonality for aggregation levels

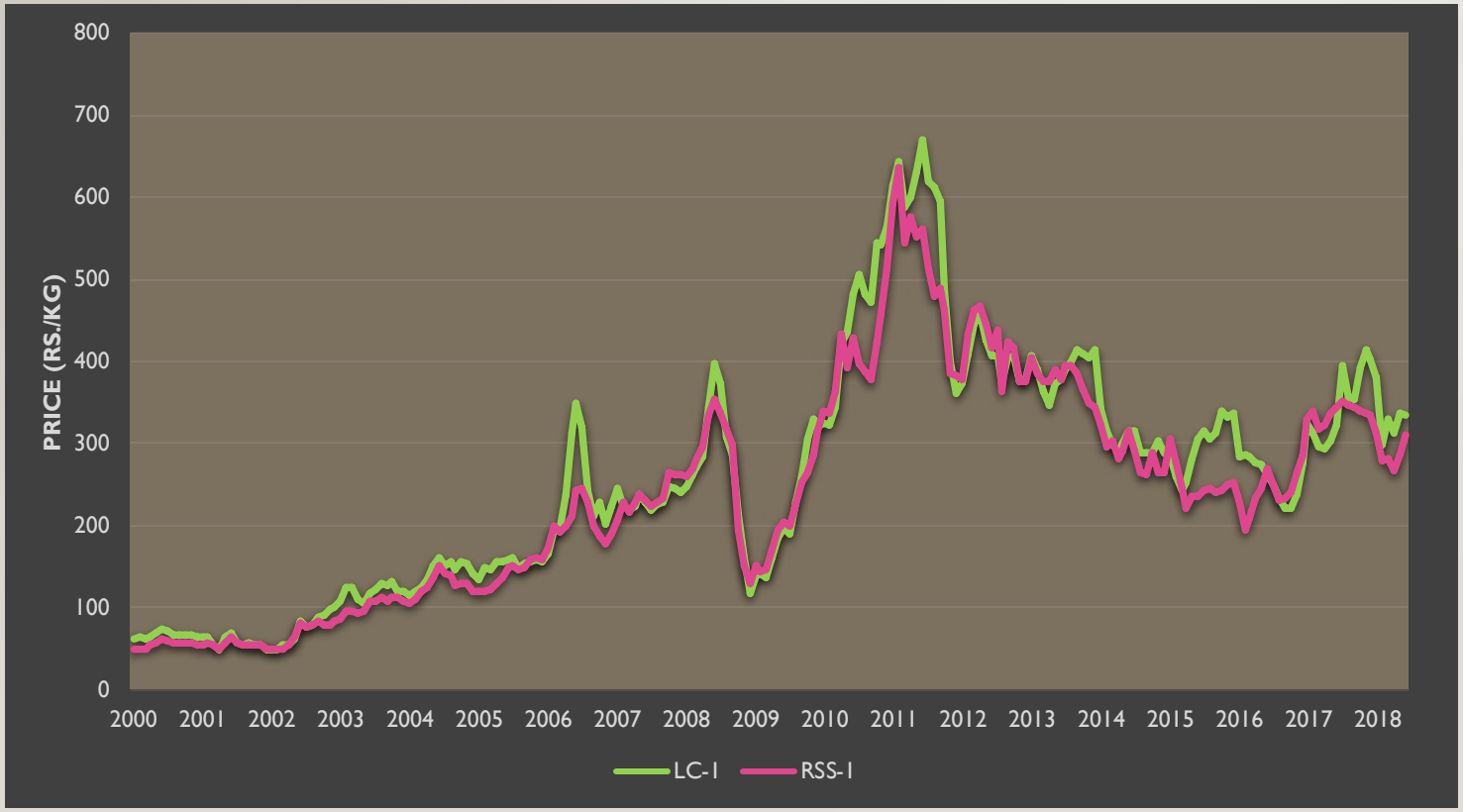


$$\hat{y}_{t+h^{[1]}}^{[1]} = \bar{l}_{t+h^{[1]}}^{[1]} + \bar{b}_{t+h^{[1]}}^{[1]} + \bar{s}_{t-s+h^{[1]}}^{[1]}$$

MEASURING THE PERFORMANCE OF THE MODELS

- Forecast horizons for the prices of LC-1 and RSS-1 : 03, 06 and 12 months
- The Mean Absolute Percentage Error (MAPE) - employed to measure and compare the performance of SARIMA, Holt Winters ETS and MAPA
- MAPE - a statistical measure to find out the accuracy of a forecast system
- $MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right|$ A_t is the actual value and F_t is the forecast value

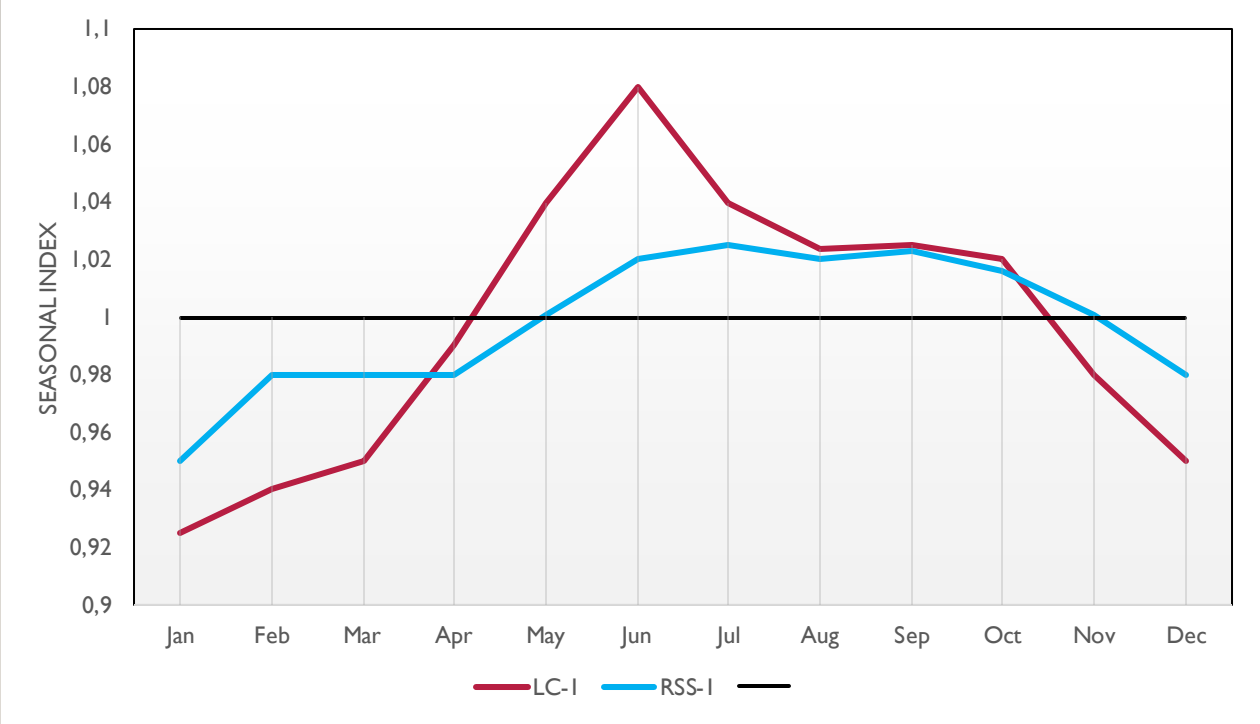
RESULTS & DISCUSSION – TS Plots



Note:

- Change in variability with time
- Close association
- Greater variability in LC-1 compared to RSS -1 prices

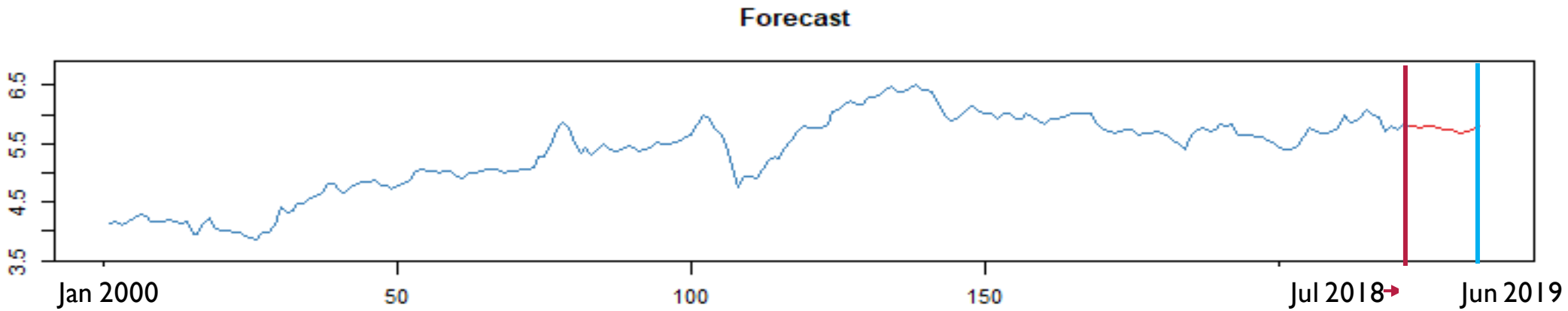
RESULTS & DISCUSSION – Seasonal Indices

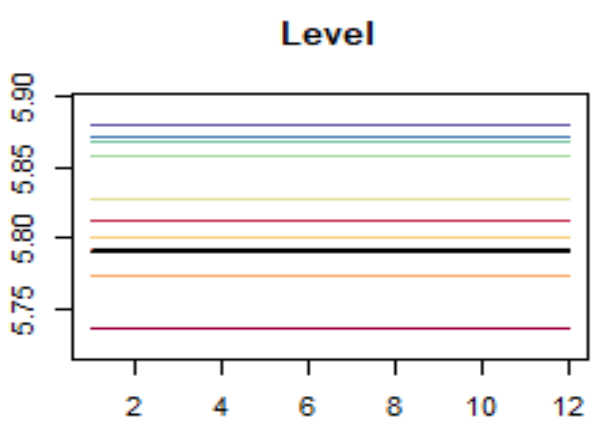


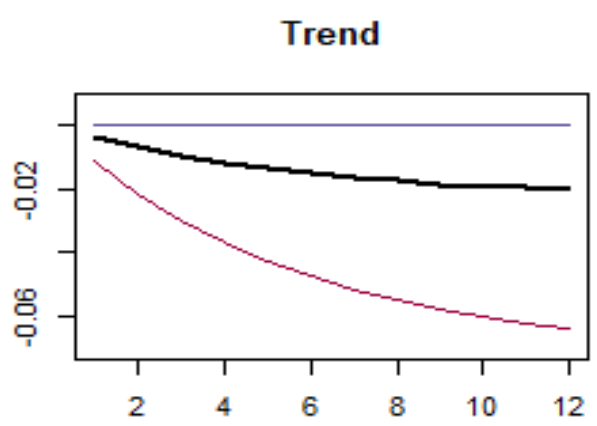
Note:

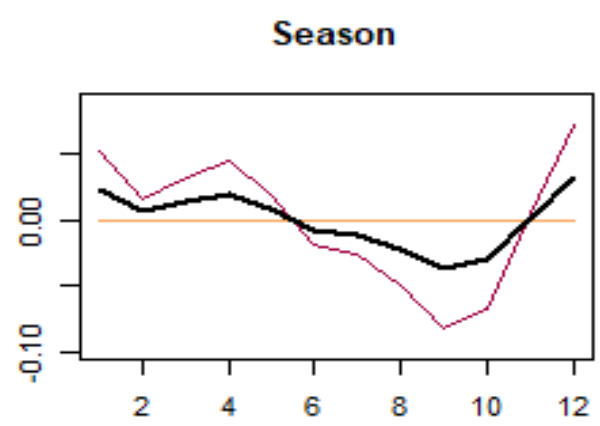
- Greater variability within year in LC-1 prices compared to RSS-1 prices
- SI is high where production is low

RESULTS & DISCUSSION – Forecasts for LC-1 from MAPA

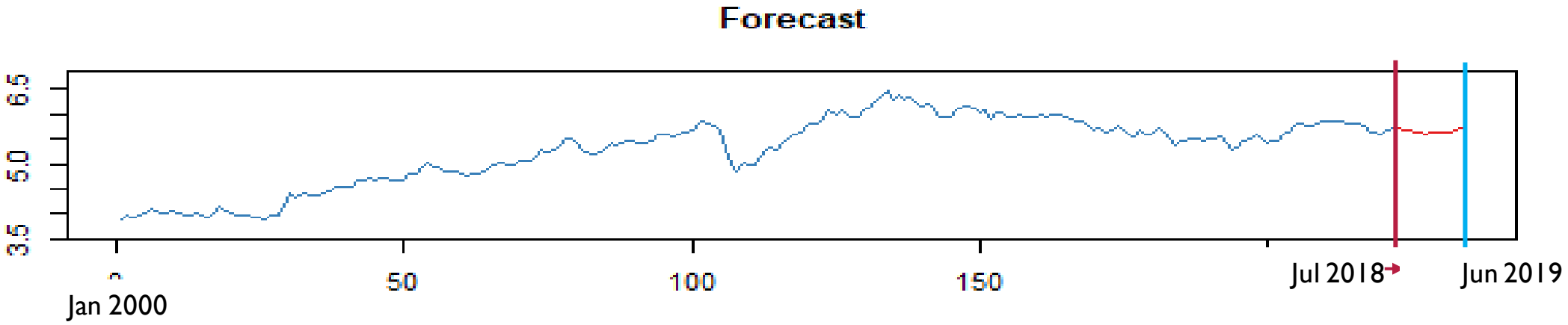


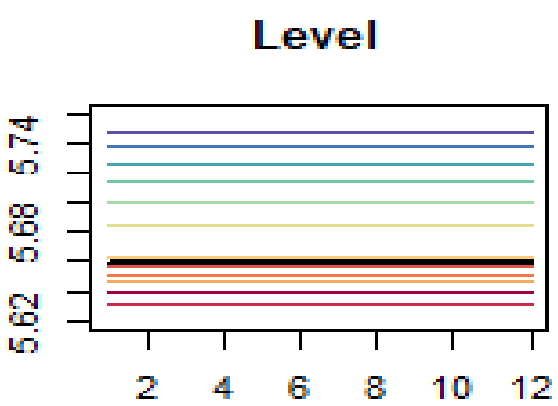


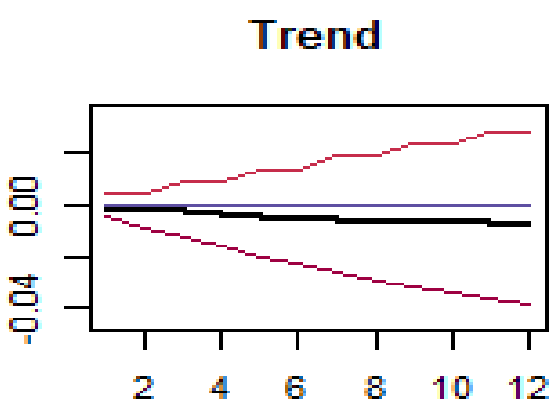


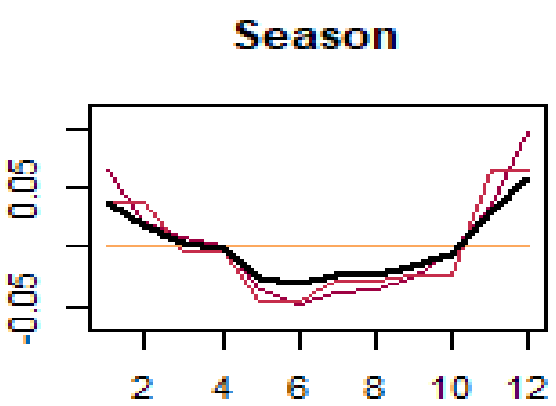


RESULTS & DISCUSSION – Forecasts for RSS-1 from MAPA

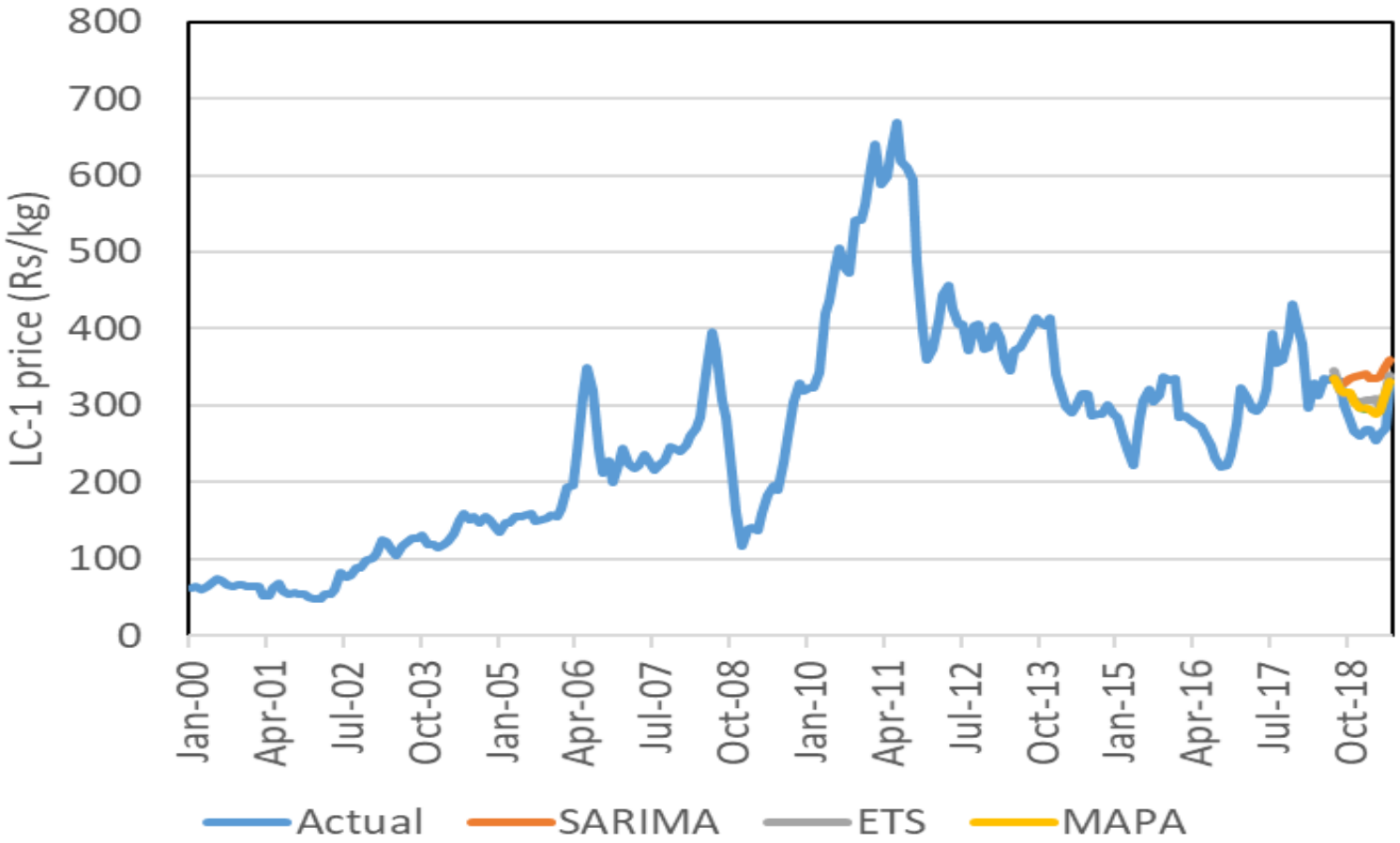




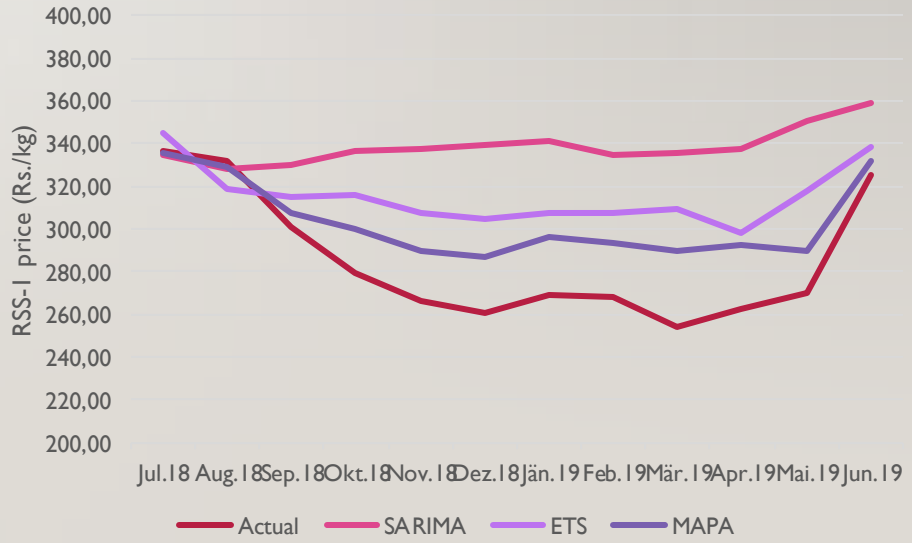




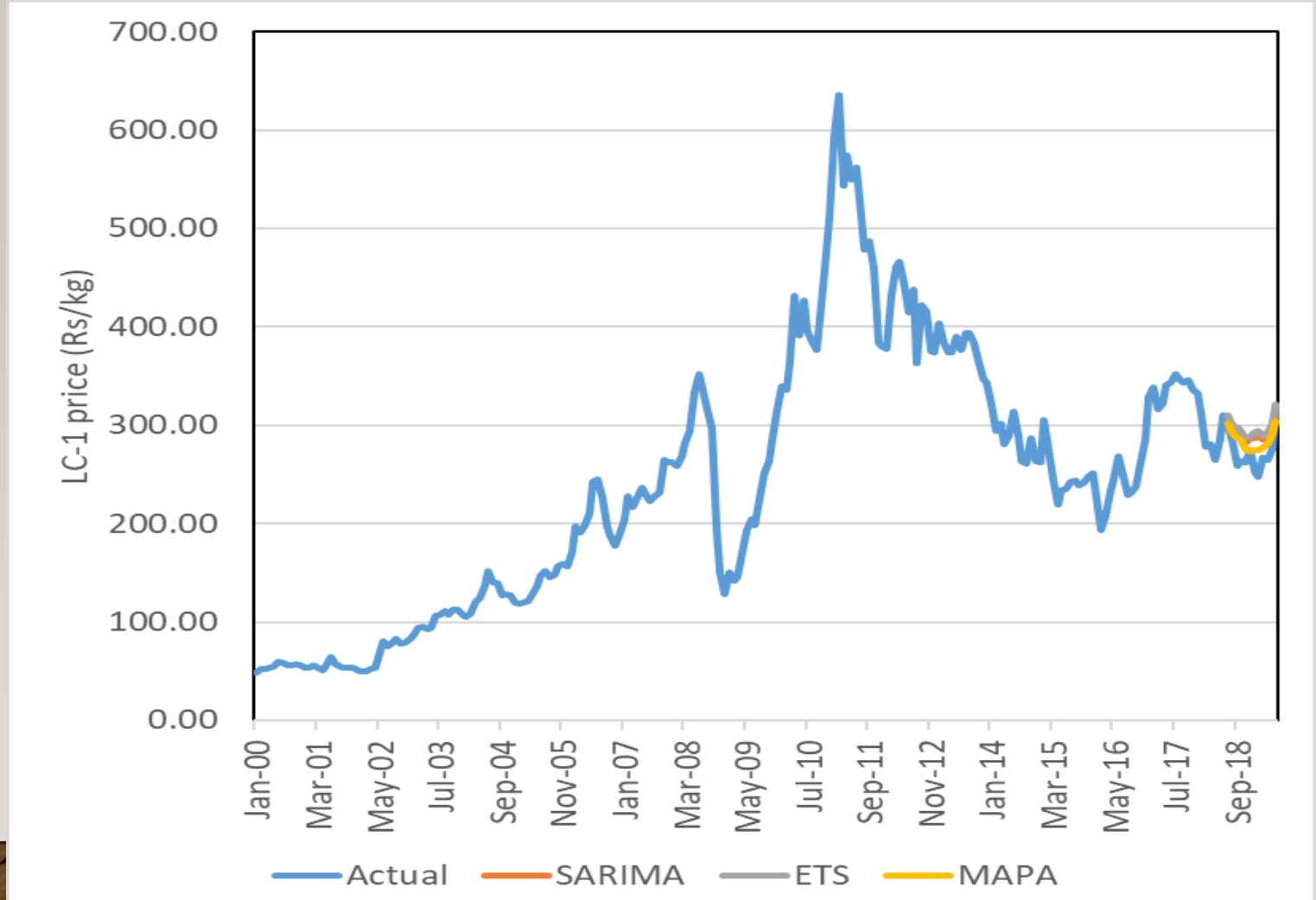
RESULTS & DISCUSSION – Comparison of Forecasts for LC-1 from ARIMA, ETS & MAPA



MAPA is closest to actual



RESULTS & DISCUSSION – Comparison of Forecasts for RSS-1 from ARIMA, ETS & MAPA



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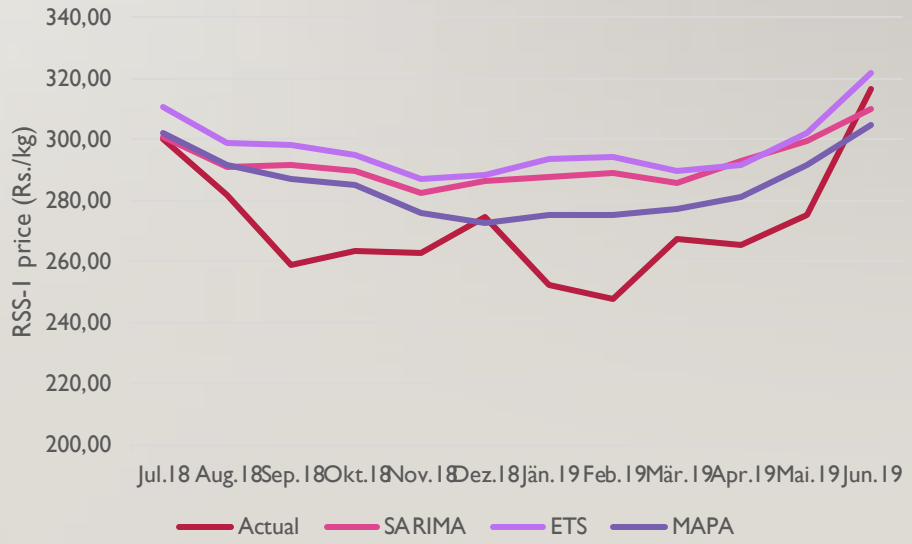
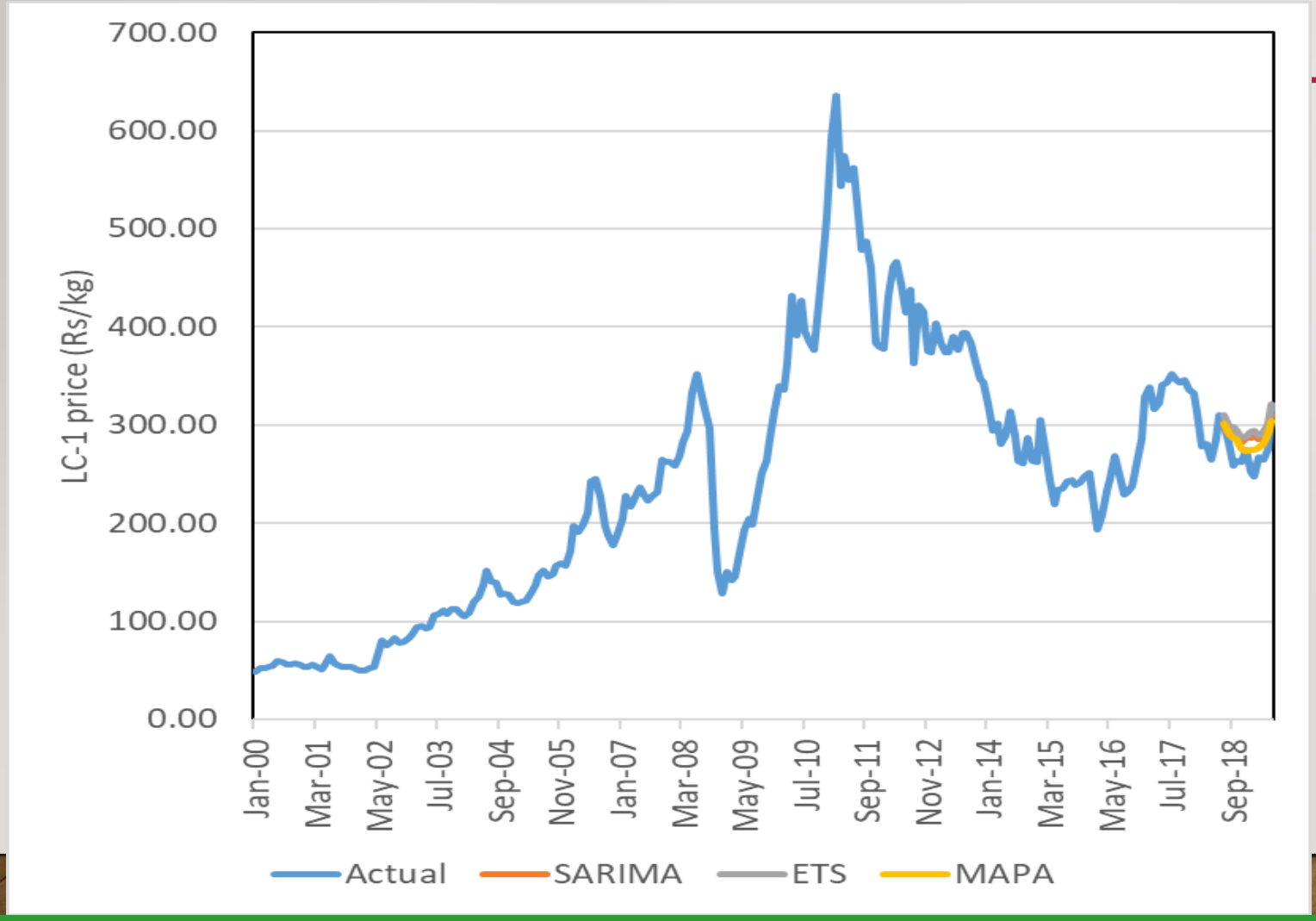


RESULTS & DISCUSSION – Comparison of Forecasts for RSS-1 from ARIMA, ETS & MAPA



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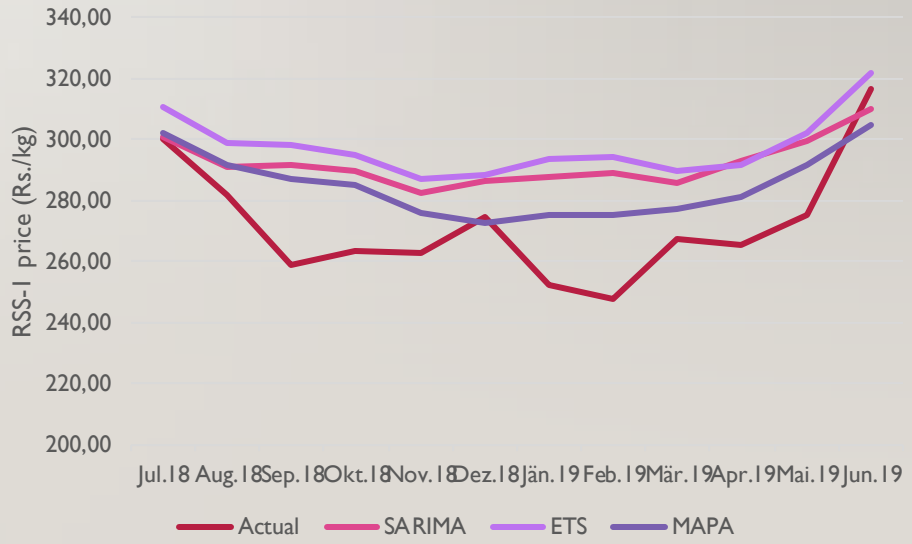

FORECASTING EFFICIENCY

LC-1 Prices			
Forecast period (months)	MAPE values (%) for forecasts using different models		
	SARIMA	ETS	MAPA
3	3.91	3.74	3.14
6	14.84	9.39	6.51
12	23.87	15.24	9.83
RSS-1 Prices			
Forecast period (months)	MAPE values (%) for forecasts using different models		
	SARIMA	ETS	MAPA
3	5.39	8.22	3.04
6	6.33	8.50	4.84
12	8.04	9.66	5.71

CONCLUSION

- The forecast efficiency of the MAPA method outperforms the seasonal ARIMA and ETS.
- Further MAPA can be used with a considerable accuracy in forecasting of prices of LC-1 and RSS-1 even up to a 12-month forecast horizon

Contacts:

Wasana Wijesuriya

wijesuriyawasana@gmail.com
wasanaw@rrisl.gov.lk