Reducing bullwhip effect: An application of CPFR technique in FMCG supply chain

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Abstract:

Paper demonstrates an application of CPFR technique, to improve efficiencies in a supply chain. The paper highlights the nature of FMCG supply chain and the advances in it.

A model is developed where statistics is used to reduce bullwhip effect and eventually overall operational cost. R and MS Excel was used for the analysis. CPFR technique is one of the most beneficial technique by which companies can reduce their distribution cost. This technique improves distribution by increasing visibility, systematic information generation and distribution.

This technique is most beneficial for the organizations which deals with short shelf life products or where markets are highly segmented or where organizations face higher variation in raw material supply or market demand. Practitioners can find this model useful for reducing cost in their organization. This model also demonstrate benefits of including information sharing applications in the process.

Keywords – Bullwhip, FMCG, CPFR, Supply Chain

1. Introduction:

Companies are trying to meet customers' demand but not at the cost of profitable growth. Main focus of such organizations is on better supply chain management. It includes better flow of goods from supplier to manufacturers to end-users. It also include the information flow which occurs among these players. Better understanding of expectations of players and collaborative efforts from them can give competitive benefit.

Many authors suggest that along with product quality and timely delivery, customer service also differentiates a company from its competitors (Cespedes, F.,1996; Johannessen, J.A., *et.al.*,1997; Kingman-Brundage.J. *et.al.*,1995). Though logistics and marketing department plays major role in customer service, other departments like HR and finance need to contribute managerial and financial resources (Christopher M., 1993; Bowersox D. J., *et.al.*,1995; Mentzer J.T. and Khan K., 1996).

As information is passed upstream in a supply chain, variability increases. This is a common phenomenon which exist in many industries (Lee H.L., *et.al.*, 1997; Fisher M. *et.al.*,1997; Zotteri G., 2013; Klug F., 2013).

This paper focus on these two concepts. Illustraion is used from a dairy industry where bullwhip effect is identified. CPFR is used to reduce the effect and affect the cost significantly.

2. Review of Literature

For consumer products, CPFR technology is getting traction. Collaboration between suppliers and distributors for stock replenishment forecasting can reduce operational cost significantly. CPFR (Collaborative Planning, Forecasting and Replenishment) is a concept which enhances supply chain process by integration. This integration is done through collaborative work of different supply chain partners. Most of the wastage in supply chain occurs because of the anticipation of higher or lower demand. Lack of information with supply chain partners results in maintaining of safety stock. Information asymmetry is sometimes created to push sales in the market. In some cases, lack of technology integration in supply chain results in partial or delayed information flow. (Bradley, Peter. Et al., 2002)

Companies either follow push or pull strategy to distribute finished products in the market. These strategies may result in overstocking, leading to higher cost of storage or obsolescence. Sometimes, it create scarcity in the market, leading to price fluctuation or lost sales.

The stages involved in CPFR modelling are:

Strategy: This stage involves defining the level of collaboration between supply chain partners. Marketing and inventory planning is also considered in this stage.

Demand & Supply: It involves forecasting of demand or prediction of sales in different markets.

Execution: Based on the forecasting in previous step, firm can initiate production, shipping and delivery of products.

Analysis: Exceptions are studied, and based on environmental factors, different processes are tweaked (Disney S.M., *et.al.*,2006; Costantino F., *et.al.*,2013).

CPFR initiatives require active participation from every level of an organization. It represents the most encompassing well defined framework for supply chain integration of the organization and it is the driver for moving into the next era of buyer-seller relationship.

CPFR as a tool to reduce Bull-Whip effect

In a supply chain, as we move up, small variation in demand reflects larger variation at top. In order to stock sufficient quantity, players add buffer to the demand placed. This addition of buffer results in larger proportion of buffer stock at the higher level in the supply chain. Sometimes, this buffer is because of delayed information also. By appropriate forecasting, part of this effect can be reduced.

Causes of Bullwhip effect:

Demand Forecast:

Organizations can go for systematic planning based on forecasting rather than intuition. Instead of using immediate variation, they can consider seasonality and trend for future planning (Ciancimino E. *et.al.*, 2012).

Order Batching:

Economic order quantity is a common concept where orders are placed in a most economical batch size. Bigger order size may result in higher inventory cost while smaller order size may result in higher overall transportation cost. Thus, demand is often consolidated before fulfilling an order. Companies may choose to order single or multiple times a year. The manufacturer receives order monthly from all the distributors. Periodic ordering amplifies variability and contributes to the Bullwhip effect (Watts, C. A. *et.al.*, 1994).

Price Fluctuation:

Manufactures and distributors periodically have special promotions like price discounts on bulk purchase or festive discounts on combo purchase. Customers purchase might be independent of consumption pattern. They may stock up larger quantities to get maximum benefit out of the reduced prices (Ciancimino E. *et.al.*, 2012).

Rationing and shortage earning:

Sometimes product demand is higher than the planned production. Thus, in anticipation of higher sales, manufacturer can divert resources for higher production. It might happen that demand can again drop resulting in over production.

3. Analysis and Results:

A distributor from Jalandhar was considered for the study. His top four retailers, contributing more than 80 % of his total sales were part of the study. Two year record was taken from distributor where average monthly demand by each retailer was recorded. These averages were rounded off to integer for the sake of better predictions.

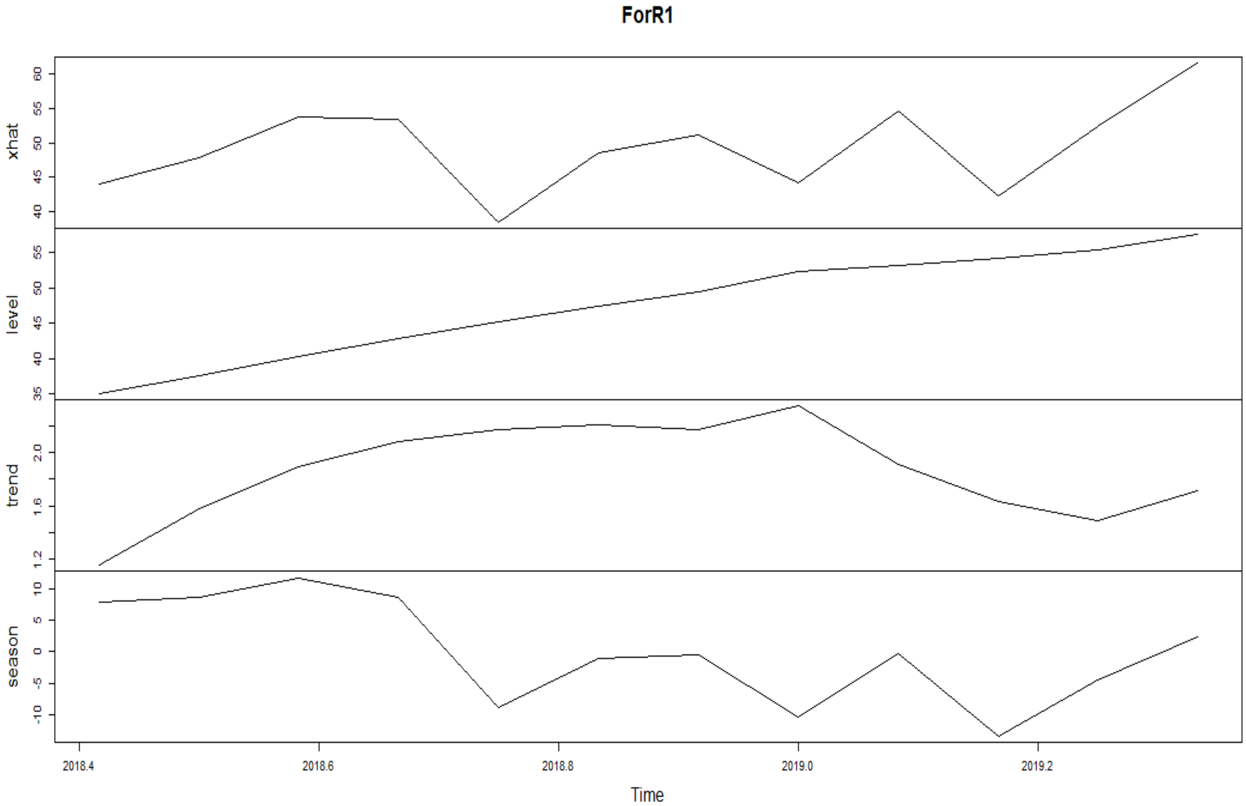
Demand by these retailers were as followed:

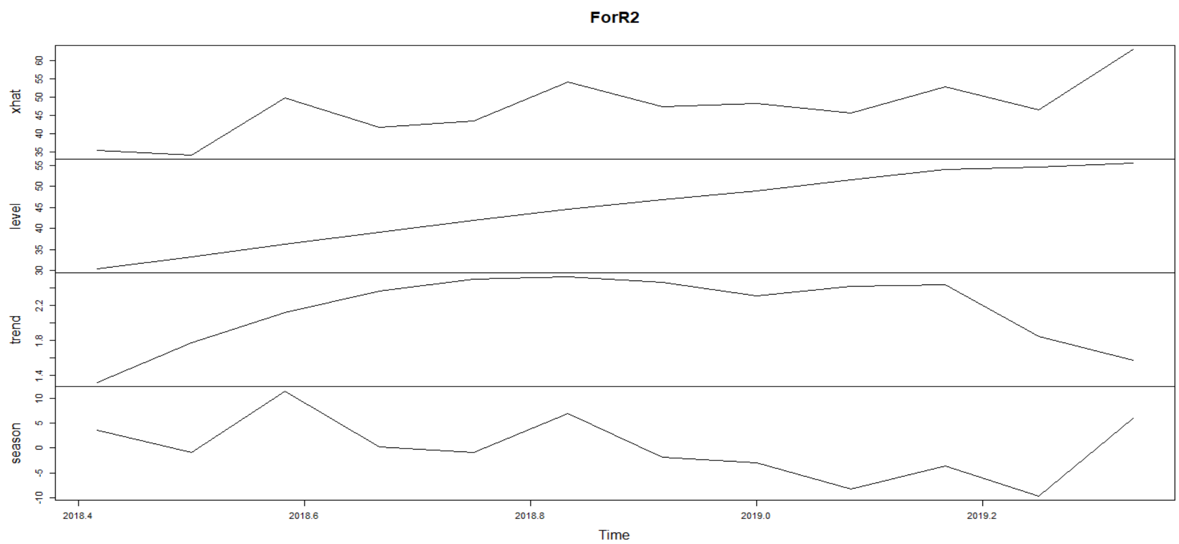
	R1	R2	R3	R4
Jun-17	41	32	41	25
Jul-17	43	25	39	43
Aug-17	43	37	34	43
Sep-17	43	29	35	30
Oct-17	27	33	36	44
Nov-17	30	34	36	40
Dec-17	36	30	45	40
Jan-18	27	30	43	25
Feb-18	38	26	45	38
Mar-18	26	32	41	27
Apr-18	36	27	27	41
May-18	44	44	26	38

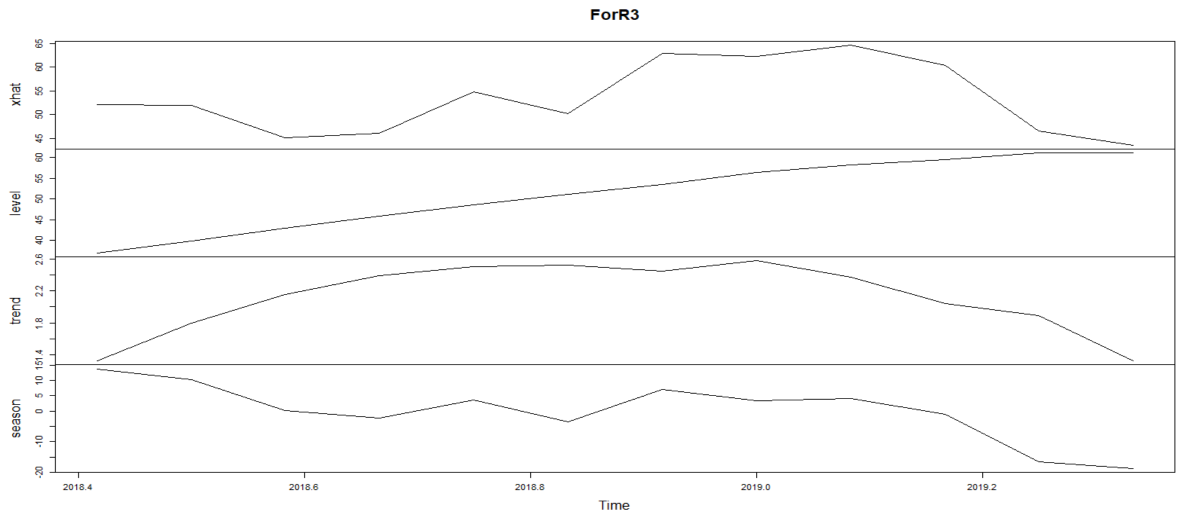
	R1	R2	R3	R4
Jun-18	51	43	60	39
Jul-18	53	40	58	60
Aug-18	57	54	49	63
Sep-18	55	44	48	47
Oct-18	39	44	55	57
Nov-18	48	53	49	52
Dec-18	54	45	65	50
Jan-19	37	50	59	45
Feb-19	50	46	59	58
Mar-19	40	43	58	41
Apr-19	56	42	37	58
May-19	56	57	44	52

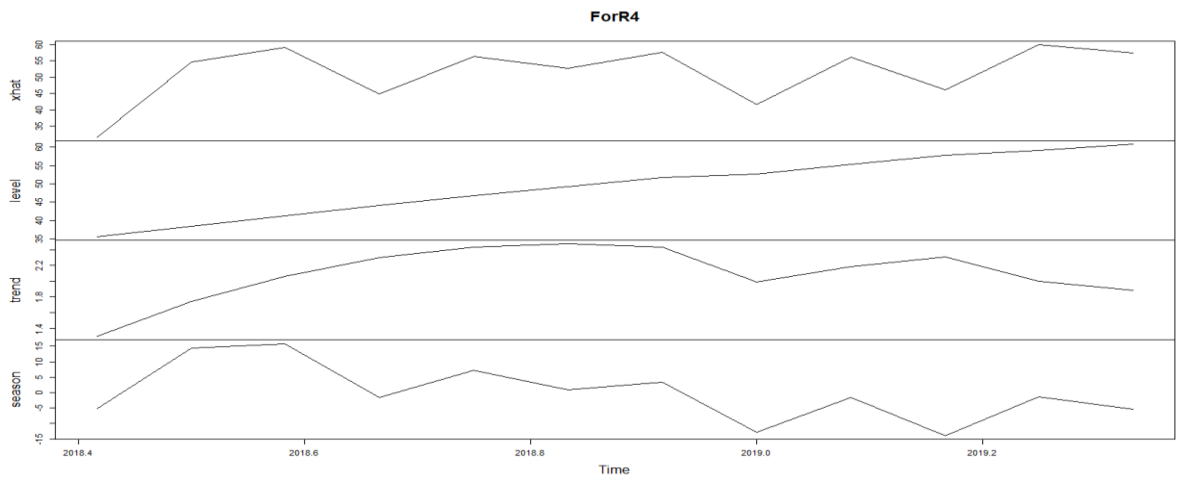
HW’s method was applied: Alpha = 0.20, Beta = 0.30, Gamma = 0.40 were used.

Break-up of data for each retailer is as followed:

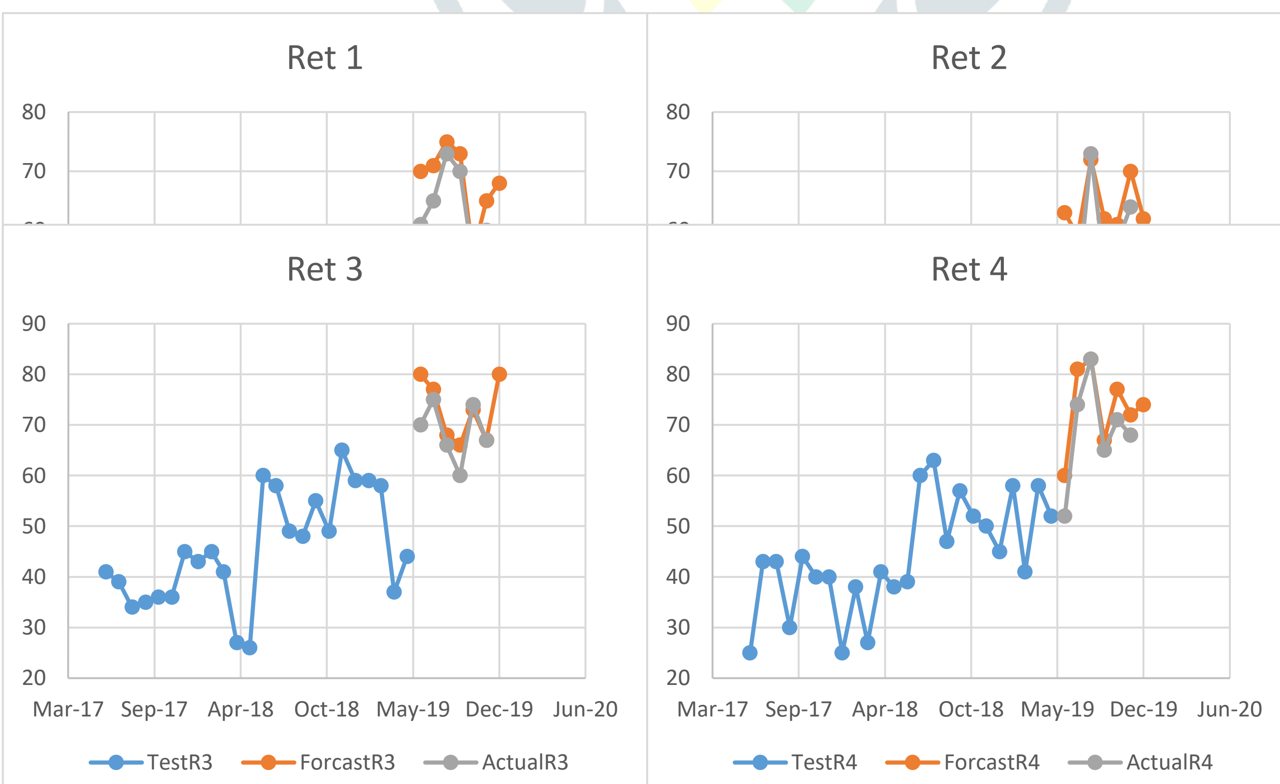








Forecasted values were mapped against actual values for each of the retailer.



Results were cross checked with the actual demand for next 6 months. Above graphs clearly shows that forecasted values were good match with the actual sales. Thus, this model was suggested to the distributor to plan his sales.

4. Conclusion:

Distributors can follow this model instead of placing orders based on monthly fluctuations. Similarly, other players in the supply chain can develop model based on the orders placed in the past. It will reduce the Bullwhip effect as stock will be kept on the basis of model and not on the basis of the fluctuation in demand.

5. Script used for the analysis

```
# Converting data to time series
a1ts=ts(a$R1,start=c(2017,6),frequency=12)
a2ts=ts(a$R2,start=c(2017,6),frequency=12)
a3ts=ts(a$R3,start=c(2017,6),frequency=12)
a4ts=ts(a$R4,start=c(2017,6),frequency=12)

# Applying HW on time series data and saving output in variables
hw1=HoltWinters(a1ts, alpha =0.20, beta = 0.30, gamma = 0.40,seasonal = "additive")
hw2=HoltWinters(a2ts, alpha =0.20, beta = 0.30, gamma = 0.40,seasonal = "additive")
hw3=HoltWinters(a3ts, alpha =0.20, beta = 0.30, gamma = 0.40,seasonal = "additive")
hw4=HoltWinters(a4ts, alpha =0.20, beta = 0.30, gamma = 0.40,seasonal = "additive")

#Fitting model and saving it in variables
ForR1=fitted(hw1)
ForR2=fitted(hw2)
ForR3=fitted(hw3)
ForR4=fitted(hw4)

# Check how fitted values looks
plot(ForR1)
plot(ForR2)
plot(ForR3)
plot(ForR4)

# Forecasting for next 10 periods
stats:::predict.HoltWinters(hw1,h=10)
```

```
f1=forecast(hw1,h=10)
rf1=round(f1$mean,0)
stats:::predict.HoltWinters(hw2,h=10)
f2=forecast(hw2,h=10)
rf2=round(f2$mean,0)
stats:::predict.HoltWinters(hw3,h=10)
f3=forecast(hw3,h=10)
rf3=round(f3$mean,0)
stats:::predict.HoltWinters(hw4,h=10)
f4=forecast(hw4,h=10)
rf4=round(f4$mean,0)
forecastR=data.frame(rf1,rf2,rf3,rf4)
forecastR
```

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