PERCENT CHANGE IN SAFETY STOCK WITH A CHANGE IN FORECAST ERROR

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ABSTRACT

This paper gives a way to measure how safety stock increases when the forecast error increases – and conversely -- how safety stock decreases when the forecast error decreases. The paper also shows how much safety stock is needed relative to the total inventory. The results of this paper brings forth the obvious need to use a sound statistical forecasting system to run the inventory operation. In essence, the smaller the forecast error, the less need for safety stock, the less inventory and the higher inventory profit margin.

Two of the key measures on the performance of the inventory system are the amount of stock on-hand and the service level. The service level SL is typically measured as the ratio of (demand filled) over (total demand). The on-hand inventory is the available inventory – usually measured in dollars. The on-hand inventory is conveniently grouped into two partitions: cycle stock and safety stock. The cycle stock is the portion of stock carried to meet the average flow of demands as planned by the forecasts over the future time periods. The safety stock is the stock carried to meet the uncertainty associated with the forecast of the demands. The uncertainty in demands is a measure of the forecast error. The typical measure of the forecast errors is the standard deviation of the one month ahead forecast error and is denoted here as σ.

SAFETY STOCK AND SERVICE LEVEL

References [1] [2] [3] show how to compute the safety stock to yield the service level goal as desired by the management. On an individual part, the data used to determine the safety stock is listed below:

SL = desired service level
F = average monthly forecast
L = lead time to procure the part from the supplier
Q = the size of the order quantity
σ = the standard deviation of the one-month ahead forecast error

For the analysis of this paper, references [2] [3] show how the order size and forecast error are converted in units of the average monthly forecast as shown below:

M = Q/F = months-in-buy
cov = σ/F = coefficient of variation

This way, the data is independent from the forecast size and is defined in relative terms. The data to determine the safety stock is now reduced to the following:

SL = desired service level
L = lead time in months

M = the order size in months supply
cov = the coefficient of variation

Reference [3] gives a series of tables that list the months of safety stock for a wide variation of situations using the data above. Three tables of this paper list some of the results from the reference. The tables are arranged as follows:

Table 1.	L = 0.25 (one week) and M = .50 (one-half month)
Table 2.	L = 1.00 (one month) and M = 1.00 (one month)
Table 3.	L = 2.00 (two months) and M = 1.00 (one month)

Each of the tables give safety stock results from five values of the service level: (SL = 0.900, 0.925, 0.950, 0.975 and 0.990) and eight values of the coefficient of variation (cov = 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8 and 1.0). Note the tables are split into two sections: upper and lower sections.

The upper section of the table lists the months of safety stock needed to yield the service level goals in association with the lead time, the month-in-buy and the coefficient of variation.

The lower section of the table lists the percent increase in safety stock that is needed to yield the service level goal (with L and M fixed) and with a 10 percent increase in the coefficient of variation (cov). In essence it is a measure of how much more safety stock (in percent) is needed when the forecast error has an increase of 10%. It also is a measure on how much less safety stock (in percent) is needed when the forecast error has a decrease of 10%.

For clarity, it is helpful to describe how the above percentages are obtained. As an example consider Table 2 where L = 1.00 and M = 1.00. Suppose the service level of interest is SL = 0.95 and the cov entries are 0.30 and 0.40. The months of safety stock for this situation is ss = 0.18 and 0.31 months supply, respectively. Below lists the results in tabular form.

SL	L	M	cov	ss
.95	1.00	1.00	0.30	0.18
.95	1.00	1.00	0.40	0.31

When the cov changes from 0.30 to 0.40, the percent increase in cov is: (0.40-0.30)/0.30 = 0.33 (33%). In a corresponding way, the percent increase in the safety stock is: (0.31-0.18)/0.18 = 0.72 (72%). So 0.72/0.33 = 2.18 or 218%. Thereby 2.18% is the percent increase in safety stock to accommodate a one percent increase in the cov. Using 10 percent as the base increase in cov, the corresponding increase in safety stock becomes 21.8%. The associated table entry lists 21.67% which differs due to rounding.

Although the discussion above describes how safety stock increases as the cov increases, the analogy holds as cov decreases. So when the cov decreases by 10%, Tables 1-3 list the percent decrease in safety stock that is expected.

CYCLE STOCK, SAFETY STOCK AND TOTAL STOCK

Table 4 is a related table that lists the months of safety stock relative to the cycle stock and the total stock. Note the average cycle stock is half the months-in-buy and thereby cs = M/2 is used here. Note also the total stock is the sum of cycle stock and safety stock (ts = cs + ss). Table 4 lists cs, ss and ts when the service level is SL = 0.95 and when L, M and cov range the same as in Tables 1-3.

Table 4 shows that the safety stock can represents a large portion of the total stock. For example, the safety stock is near 50 percent of the total stock when the coefficient of variation (cov) is .50. The safety stock is over 50 percent of the total stock when cov is greater than 0.50.

SUMMARY

This paper shows how much less safety stock is needed when the forecast error decreases by 10 percent. With this knowledge, it behooves the inventory management to insist on using a good forecast system – one built with sound statistical techniques. Note that in many inventory operations, safety stock represents a large portion of the total inventory – 50 percent is common – and thereby a reduction in the safety stock will significantly reduce the total inventory – and this leads to lower inventory costs and higher profits.

REFERENCES

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