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Abstract:

The basic financial purpose of a firm is to maximize its value. An inventory management system should also contribute to the realization of this basic aim. Many current asset management models found in financial management literature were constructed with the assumption of book profit maximization as their basic aim. However these models could lack the means for realizing a different aim, i.e., the maximization of enterprise value. This article presents a modified value-based inventory management model.

Keywords: inventory management, value-based management, free cash flow, working capital management, short-run financial management

JEL: G32, G11, M11, D81, O16, P33, P34

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1. Introduction

The basic financial aim of an enterprise is the maximization of its value. At the same time, research into the determinants in increasing firm value has considerable theoretical and practical significance. Most financial literature contains information about numerous factors influencing value. Among those factors are net working capital and the elements creating it, such as the level of cash tied in accounts receivable, inventories and operational cash balances. A large majority of classic financial model proposals related to optimum current assets management were constructed with net profit maximization in view. In order to make these models more suitable for firms that want to maximize their value, some of them must be reconstructed. In the sphere of inventory management, the estimation of the influence of changes in a firm’s decisions is a compromise between limiting risk by having greater inventory and limiting the costs of inventory. It is the essential problem of corporate financial management.


The basic financial purpose of an enterprise is the maximization of its value. Inventory management should
future free cash flow is expressed:

discounted by the cost of the capital financing the firm:

is a sum of future free cash flows to the firm ($FCFF_t$) discounted by the cost of the capital financing the firm:

\[ FCFF_t = (CR_t - CE_t - NCE) \times (1 - T) + NCE - Capex - \Delta NWC_t, \tag{2} \]

where $CR_t$ = cash revenues on sales; $CE_t$ = cash expenses resulting from fixed and variable costs in time $t$; $NCE$ = non-cash expenses; $T$ = effective tax rate; $\Delta NWC$ = net working growth; and $Capex$ = capital expenditure resulting from operational investments growth (money used by a firm to acquire or upgrade physical assets such as property, industrial buildings, or equipment).

Similar conclusions about the results of a change in inventory management policy on firm value can be estimated on the basis of economic value added, which reveals the size of the residual profit (the added value) and enlargement of the firm’s value in the period:

\[ EVA = NOPAT - k \times (NWC + OI), \tag{3} \]

where $EVA$ = economic value added; $NWC$ = net working capital; $OI$ = long-term operating investments; and $NOPAT$ = net operating profit after taxes, estimated on the basis of the formula:

\[ NOPAT = (CR_t - CE_t - NCE) \times (1 - T) \tag{4} \]

The net working capital (NWC) is a part of current assets financed with fixed capital. The net working capital (current assets less current liabilities) results from the lack of synchronization of the formal rising receipts and the real cash receipts from each sale. Net working capital also results from divergence during a time of rising costs and from the real outflow of cash when a firm pays its accounts payable.

\[ NWC = CA - CL = AAR + INV + G - AAP \tag{5} \]

where $NWC$ = net working capital; $CA$ = current assets; $CL$ = current liabilities; $AAR$ = average level of accounts receivable; $INV$ = inventory; $G$ = cash and cash equivalents; and $AAP$ = average level of accounts payable.

During estimation of the free cash flows the holding and increasing of net working capital ties money used for financing it. If net working capital increases, the firm must tie money, thus decreasing free cash flows. Production level growth usually creates a necessity for the enlargement of cash levels, inventories, and accounts receivable. Part of this growth will be covered by current liabilities. Current liabilities also usually automatically increase alongside growth in production. The rest (which is noted as net working capital growth) will require other forms of financing.

\[ \Delta V_p = \sum_{t=1}^{n} \frac{\Delta FCFF_t}{(1 + k)^t}, \tag{1} \]

where $\Delta V_p$ = firm value growth; $\Delta FCFF_t$ = future free cash flow growth in period $t$; and $k$ = discount rate$^1$.

Future free cash flow is expressed:

$^1$ To estimate changes in accounts receivable levels, a discount rate equal to the average weighted cost of capital (WACC) is accepted. Such changes and their results are strategic and long term in character, although they refer to accounts receivable and short run area decisions (T.S. Maness 1998, s. 62-63).
Inventory management policy decisions create the new inventory level in a firm. These decisions have influence on firm value. It is the result of opportunity costs of money tied in with inventory and the general costs of inventory management. Both the first and second involve the modification of future free cash flows, leading to changes in firm value. Figure 1 shows the influence of inventory management decisions on firm value. These decisions change the future free cash flows (FCFF). These decisions could also have influence on the life of the firm (t) (by the operational risk, which is the result of the possibility of a break in production cycles if the inventory level is too low), and the rate of the cost of capital financing of the firm (k). Changes to these three components have an influence on the creation of firm value (ΔVp).

The Economic Order Quantity Model is a model which maximizes the firm’s income through total inventory cost minimization.

The EOQ model requires two equations:

\[
EOQ = \sqrt{\frac{2 \times P \times K_z}{C \times v}} = \sqrt{\frac{2 \times P \times K_z}{K_u}}, \quad (6)
\]

where \( EOQ \) = economic order quantity; \( P \) = demand for the product/inventory in period (year, month); \( K_z \) = cost per order; \( K_u \) = holding cost per unit in period (year, month); \( C \) = holding cost factor; and \( v \) = purchase cost per unit.

The holding cost factor (\( K_u \)) is a result of the following costs:

- Opportunity costs (price of money tied-up in inventory)
- Storage, insurance, transportation, obsolescence, waste and spoilage costs

\[
TCI = \frac{P}{Q} \times K_z + \left( \frac{Q}{2} + z_b \right) \times v \times C, \quad (7)
\]

where \( TCI \) = total costs of inventory; \( Q \) = order quantity; and \( z_b \) = minimal stock.

Example 1. \( P = 220 \, 000 \) kg; \( K_z = 31 \) $; \( v = 2 \) $ / kg; \( C = 25\% \). Effective tax rate, \( T = 19\% \). Cost of capital financing the firm \( WACC = k = 15\% \); \( z_b = 300 \) kg.

First EOQ is estimated:
\[ EOQ = \sqrt{\frac{2 \times 220 \,000 \times 31}{0.25 \times 2}} = 5223 \text{ kg}. \]

Next average inventory level is estimated:
\[ INV_{EOQ=5223} = \frac{5 \times 223}{2} + 300 = 2912 \text{ kg} \Rightarrow INV_{EOQ=5223} = 2912 \times 2 = 5824 \$

\[ TCI_{EOQ=5223} = \frac{220 \,000}{5223} \times 31 + \left( \frac{5 \times 223}{2} + 300 \right) \times 2 \times 0.25 = 2762 \$

If 5000 kg are ordered, the quantity \( EOQ = 5223 \) kg, and the TCI are:
\[ TCI_{Q=5000} = \frac{220 \,000}{5000} \times 31 + \left( \frac{5 \times 5000}{2} + 300 \right) \times 2 \times 0.25 = 2764 \$

\( TCI \) will be greater, but if its influence on firm value is checked, it will be seen that if the decision is made to order less than \( EOQ \) suggests, this will increase the firm value:
\[ \Delta TCI_{Q=5223\rightarrow Q=5000} = 2764 - 2762 = 2 \$

\[ INV_{Q=5000} = 2 \times \left( \frac{5 \times 5000}{2} + 300 \right) = 5600 \$

\[ \Delta INV_{Q=5223\rightarrow Q=5000} = 5600 - 5824 = -224 \$

\[ \Delta NWC = \Delta INV, \]

\[ \Delta V_{Q=5223\rightarrow Q=5000} = 224 - 2 \times 1.019 \frac{1}{0.15} = 213.2 \$

\[ \Delta EVA_{Q=5223\rightarrow Q=5000} = \Delta NOPAT - k \times (\Delta NWC + \Delta OI) \]

\[ = (1 - 0.19) \times (-2) - 0.15 \times (-224) = 32 \$

Because both \( \Delta V \) and \( \Delta EVA \) are greater than 0, it can be seen that it will be profitable for the firm to order 5000 kg, not 5223 kg as suggested by \( EOQ \). The \( EOQ \) model minimizes operational inventory costs, but in firm management there are also the opportunity costs of holding inventories. These costs dictate that the order will be less than that suggested by \( EOQ \) so as to maximize the firm value. With this in mind the \( VBEOQ \) model can be used:
\[ VBEOQ = \sqrt{\frac{2 \times (1-0.19) \times 31 \times 220 \,000}{2 \times (0.15 + 0.25 \times (1-0.19))}} = 3959 \text{ kg}; \]

\[ TCI_{VBEOQ=3959} = \frac{220 \,000}{3959} \times 31 + \left( \frac{3 \times 3959}{2} + 300 \right) \times 2 \times 0.25 = 2862 \$

\[ \Delta TCI_{Q=5223\rightarrow Q=3959} = 2862 - 2762 = 100 \$

\[ INV_{VBEOQ=3959} = 2 \times \left( \frac{3 \times 3959}{2} + 300 \right) = 4559 \$

\[ \Delta INV_{Q=5223\rightarrow Q=3959} = 4559 - 5824 = -1265 \$

\[ \Delta V_{Q=5223\rightarrow Q=3959} = 1265 - 100 \times 1 = 725 \$

\[ \Delta EVA_{Q=5223\rightarrow Q=3959} = (1 - 0.19) \times (-100) - 0.15 \times (-1265) = 109 \$

Both \( \Delta V \) and \( \Delta EVA \) are greater than before if the firm’s order of 3959 kg is marked by \( VBEOQ \). In fact it is the best known possibility.

4. POQ and VBPOQ

A production order quantity model (POQ) is an \( EOQ \) modification that can be used when production possibilities exceed the market’s capacity.

For Alfa data:
\[ VBEQ = \sqrt{\frac{2 \times K \times P}{C \times k \times (1 - \frac{P}{m})}} \]

where \( k = \text{cost of capital financing the firm (WACC)}; \) and \( VBEQ = \text{value based economic order quantity.} \)

\[ POQ = \sqrt{\frac{2 \times K \times P}{C \times k \times (1 - \frac{P}{m})}} \]

\[ , \quad P < m \]

\[ (8) \]
where $POQ$ = production order quantity; $K_z$ = switch on production cost (setup cost per setup); $P$ = demand intensity (how much can be sold annually); $v$ = cost per unit; $m$ = maximum annual production ability; and $C$ = holding cost factor.

$$TCI = \frac{Q}{2} \times \left(1 - \frac{P}{m}\right) \times v \times C + \frac{P}{Q} \times K_z$$

(10)

where $Q$ = production quantity; and $TCI$ = total cost of inventories.

$$INV = \frac{Q}{2} \times \left(1 - \frac{P}{m}\right)$$

(11)

Where $INV$ = average inventory level.

**Example 2.** Maximum demand, $P = 2500$ tons, $m = 10000$ tons annually. WACC = $k = 15\%$, $C = 25\%$, $T = 19\%$, $K_z = 12000$ $\$, $v = 0.8$ $\$.

First $POQ$ is estimated:

$$POQ = \sqrt{\frac{2 \times 12000 \times 2500}{800 \times 0.25 \times \left(1 - \frac{2500}{10000}\right)}} = 633$ tons.

$$TCI_{POQ=633} = \frac{633}{2} \times \left(1 - \frac{2500}{10000}\right) \times 800 \times 0.25 + \frac{2500}{633} \times 12000 = 94868$.$

$$INV_{POQ=633} = \frac{633}{2} \times \left(1 - \frac{2500}{10000}\right) = 237 (1000)$ $kg$.

$\Rightarrow 237 \times 800 = 189600$ $\$

The following check the influence of firm value on the change of production quantity to 90% $POQ$, 633 $\times 0.9 = 570$ tons:

$$TCI_{POQ=570} = \frac{570}{2} \times \left(1 - \frac{2500}{10000}\right) \times 800 \times 0.25 + \frac{2500}{570} \times 12000 = 95382$.$

$$-\Delta FCF \times \frac{1}{0.81} = \Delta TCI_{Q=633-\cdots Q=570}

= 95382 - 94868 = 514$.

From this it was found that $VBPOQ$ gives 479 tons. Table 1 also shows that the costs $TCI$ for $VBPOQ$ will be greater than for $POQ$, but that $VBPOQ$ ties up less cash in inventories than the $POQ$, which is the source of benefits in lower opportunity costs.

To estimate $VBPOQ$ the following equation could also be used:

$$Q_{VBPOQ} = \sqrt{\frac{2 \times P \times K_z \times (1-T)}{v \times \left(1 - \frac{P}{m}\right) \times \left[k + C \times (1-T)\right]}}.$$

(12)

$P < m$

Knowing $VBPOQ$, the firm can better manage inventories and bring the firm closer to realizing its basic financial aim – firm value maximization.
5. Conclusions

Maximization of the owners’ wealth is the basic financial goal in enterprise management. Inventory management techniques must contribute to this goal. Modifications to both the value-based EOQ model and value-based POQ model may be seen in this article. Inventory management decisions are complex. Excess cash tied up in inventory burdens the enterprise with high costs of inventory service and opportunity costs. By contrast, higher inventory stock helps increase income from sales because customers have greater flexibility in making purchasing decisions and the firm decreases the risk of unplanned breaks in production. Although problems connected with optimal economic order quantity and production order quantity remain, it can be concluded that the value-based modifications implied by these two models will help managers make better value-creating decisions in inventory management.

Literature