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VALUE BASED INVENTORY MANAGEMENT

1. Introduction

The basic financial aim of an enterprise is maximization of its value. In the same time, a large both theoretical and practical meaning has the research for determinants increasing the firm value. The financial literature contains information about numerous factors influencing the value. Among those factors is the net working capital, and elements creating it, such as the level of cash tie in account receivable, inventories and operational cash balances. The great part of classic financial models proposals relating to the optimum current assets management was constructed with net profit maximization in view. It is reason, why these models need reconstruction, which make its will be suitable for firms which want to maximize their value. The estimation of the influence of changes in firm decisions in sphere of inventory management, is a compromise between limiting of risk by having greater inventory level and limiting costs of inventory. It is the essential problem of the corporate financial management. The basic financial inventory management aim is holding the inventory on minimal acceptable level because of its costs. Holding inventory ties capital used to finance inventory and links with inventory storage, insurance, transport, obsolescence, wasting and spoilage costs. On the other hand, to low level of inventory, could be source of problems with meeting the supply.

2. Value based inventory management

If advantages from holding inventory on a level defined by the firm will be greater than the negative influence of an alternative costs from its holding, then the firms value will grow. Change of the accounts receivable level affects on the firm value. To measure that, we use a formula, basing on an assumption, that the firm

value is a sum of future free cash flows to firm (*FCFF*) discounted by cost of capital financing the firm:

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

where: ΔV_p – Firm Value Growth, $\Delta FCFF_t$ – Future Free Cash Flow Growth in Period t, k – Discount Rate[1].

Future free cash flow we have as:

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

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, ΔNWC – Net Working Growth, $Capex$ – Capital Expenses resulting from operational investments growth.

The similar conclusions, about the results of the change inventory management policy on the firm value, can be estimated on the basis of an economic value added, informing about the size of the residual profit (the added value) enlarged the value of the firm 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, $NOPAT$ – Net Operating Profit After Tax, estimated on the basis of the formula:

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

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

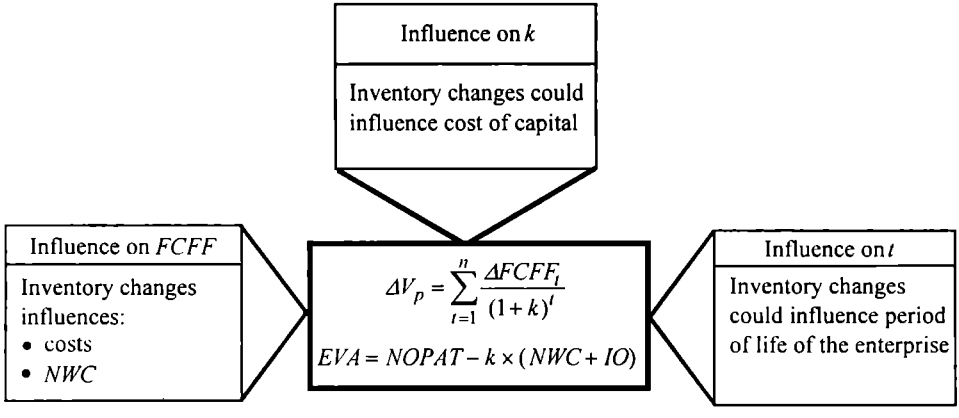
$$NWC = CA - CL = AAR + INV + G - AAP, \tag{5}$$

where: NWC – Net Working Capital, CA – Current Assets, CL – Current Liabilities, AAR – Accounts Receivables, INV – Inventory, G – Cash and Cash Equivalents, AAP – Accounts Payables.

[1] To estimate changes in accounts receivable levels, we accept discount rate equal to the average weighted cost of capital (WACC). Such changes and their results are strategic and long term in their character, although they refer to accounts receivable and short run area decisions [6, pp. 62-63].

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 increase, the firm must tie much money and it decrease free cash flows. The production level growth usually makes the necessity of enlargement of cash levels, inventories, and accounts receivable. Part of this growth will be covered with current liabilities. For current liabilities also usually automatically grow up together with the growth of production. The rest (which is noted as net working capital growth) will require other form of financing.

The inventory management policy decisions, create the new inventory level in firm. It has the influence on the firm value. It is result of alternative costs of money tie in inventory and generally of costs of inventory managing. Both the first and the second involve modification of future free cash flows, and in consequence the firm value changes. On figure 1, we have the influence of inventory management decisions on the firm value. These decisions changes the future free cash flows (*FCFF*). These decisions could also influence on life of the firm (t) (by the operational risk, which is the result of possibility to break production cycles if the inventory level is too low), and rate of the cost of capital financing the firm (k). The changes of these three components have influence on the creation the firm value (ΔVp).



where: *FCFF* – Free Cash Flows to Firm; ΔNWC – Net Working Capital Growth; k – cost of the capital financing the firm; t – the lifetime of the firm and time to generate single *FCFF*.

Fig. 1. The inventory management decision influence on firm value

Source: own study.

Inventory changes (resulting from changes in inventory management policy of the firm) affect the net working capital level and as well the level of operating costs of inventory management in a firm. These operating costs are result of storage, insurance, transport, obsolescence, wasting and spoilage of inventory.

3. *EOQ* and *VBEOQ*

Economic order quantity model is a model chich maximizes the firm income by total inventory costs minimization.

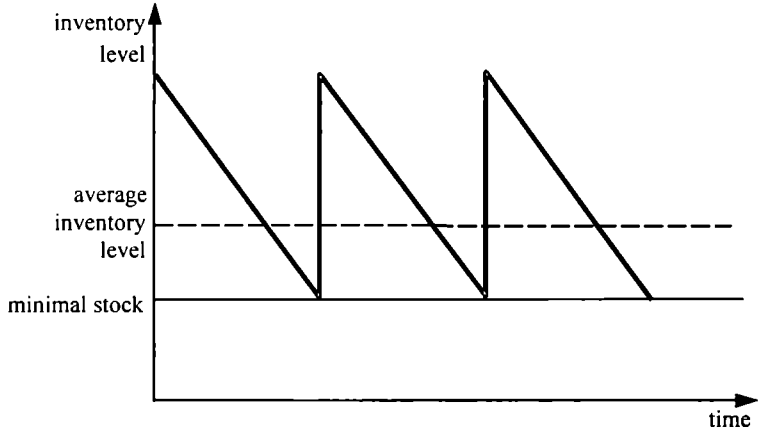


Fig. 2. *EOQ* and *VBEOQ* model

Source: [4, p. 538].

To *EOQ* model we have two equations:

$$EOQ = \sqrt{\frac{2 \times P \times K_z}{C \times v}} = \sqrt{\frac{2 \times P \times K_z}{K_u}}, \tag{6}$$

where: *EOQ* – Economic Order Quantity, P – Demand for the Product/Inventory in period (year, month), K_z – Cost per Order Event, K_u – Holding Cost per unit in period (year, month), C – Holding Cost Factor, v – Purchase Cost per Unit.

Holding cost factor (K_u) is a result of costs [13, p. 112]:

- Alternative costs (price of money tie in inventory),
- Storage, insurance, transport, obsolescence, wasting and spoilage costs.

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

where: *TCI*– Total Costs of Inventory, *Q*– Order Quantity, z_b – Minimal Stock.

Example 1. $P = 220\,000$ kg, $K_z = 31$ \$, $v = 2$ \$ / 1 kg, $C = 25\%$. Effective tax rate, $T = 20\%$. Cost of capital financing the firm $WACC = k = 15\%$, $z_b = 300$ kg.

First we estimate *EOQ*:

$$EOQ = \sqrt{\frac{2 \times 220\,000 \times 31}{0{,}25 \times 2}} = 5\,223 \text{ kg}.$$

Next we estimate average inventory level:

$$INV_{EOQ} = \frac{5\,223}{2} + 300 = 2\,912 \text{ kg} \Rightarrow INV_{EOQ} = 2\,912 \times 2 = 5\,824 \$,$$

$$TCI = \frac{220\,000}{5\,223} \times 31 + \left(\frac{5\,223}{2} + 300\right) \times 2 \times 0{,}25 = 2\,762 \$.$$

If we rather will order 5 000 kg than *EOQ* = 5 223 kg:

$$TCI_{5000} = \frac{220\,000}{5\,000} \times 31 + \left(\frac{5\,000}{2} + 300\right) \times 2 \times 0{,}25 = 2\,764 \$.$$

We will have greater *TCI*, but if we check how it influence on the firm value, we will see that if we decide to order less than *EOQ* suggest, we will increase the firms value:

$$\Delta TCI_{5000} = 2\,764 - 2\,762 = 2 \$.$$

$$INV_{5000} = 2 \times \left(\frac{5\,000}{2} + 300\right) = 5\,600 \$.$$

$$\Delta INV_{5000} = 5\,600 - 5\,824 = -224 \$.$$

$$\Delta NWC = \Delta INV.$$

$$\Delta V_{5000} = 224 - \frac{2 \times (1 - 0{,}2)}{0{,}15} = 213{,}33 \$,$$

EOQ model minimize operational inventory costs, but in firm management we also have alternative costs of holding inventories. These costs need that we will order less than *EOQ* if we want maximize the firm value. Knowing that we can use *VBEOQ* model:

$$VBEOQ = \sqrt{\frac{2 \times (1 - T) \times K_Z \times P}{v \times (k + C \times (1 - T))}}, \tag{8}$$

where: k – Cost of Capital financing the Firm (*WACC*); *VBEOQ* – Value Based Economic Order Quantity.

For Alfa data, we have:

$$VBEOQ = \sqrt{\frac{2 \times (1 - 0{,}2) \times 31 \times 220\,000}{2 \times (0{,}15 + 0{,}25 \times (1 - 0{,}2))}} = 3\,948{,}24 \approx 3\,948 \text{ kg}.$$

$$TCI_{3948} = \frac{220\,000}{3\,948} \times 31 + \left(\frac{3\,948}{2} + 300\right) \times 2 \times 0{,}25 = 2\,864{,}46\ \$,$$

$$\Delta TCI_{3948} = 2\,864{,}46 - 2\,762 = 102{,}46\ \$,$$

$$INV_{3948} = 2 \times \left(\frac{3\,948}{2} + 300\right) = 4\,548\ \$,$$

$$\Delta INV_{3948} = 4\,548 - 5\,824 = -1\,276\ \$,$$

$$\Delta V_{3948} = 1\,276 - \frac{102{,}46 \times (1 - 0{,}2)}{0{,}15} = 729{,}55\ \$.$$

4. *POQ* and *VBPOQ*

Production order quantity model (*POQ*) is the *EOQ* modification which we can use, when we have grater production possibilities than market capacity.

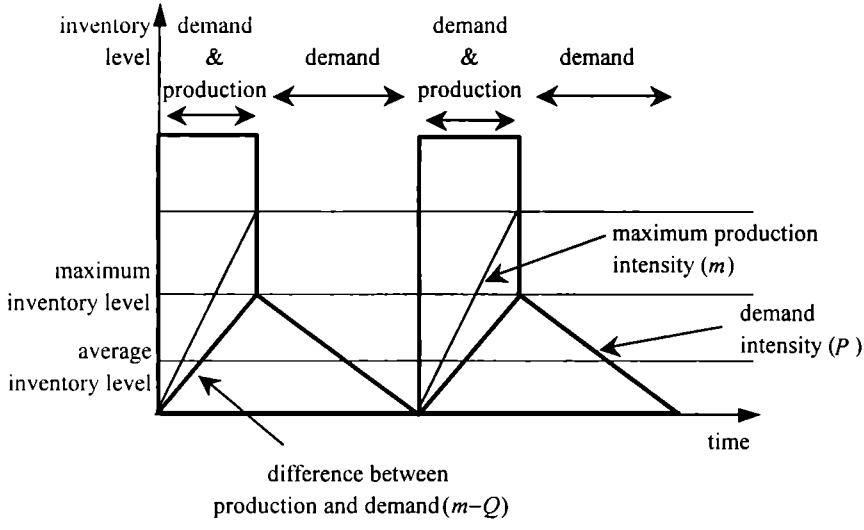


Fig. 3. *POQ* and *VBPOQ*

Source: [10, p. 162].

POQ could be estimated as [10, p. 162]:

$$POQ = \sqrt{\frac{2 \times K_z \times P}{C \times k \times \left(1 - \frac{P}{m}\right)}},\ P < m, \tag{9}$$

where: POQ – Production Order Quantity, K_z – Swith On Production Cost, P – Demand Intensity (how much we can sell annualy), v – Cost per Unit, m – Maximum Annual Production Ability, C – Holding Cost Factor.

$$TCI = \frac{Q}{2} \times \left(1 - \frac{P}{m}\right) \times v \times C + \frac{P}{Q} \times K_z, \tag{10}$$

where: Q – Production Quantity; TCI – Total Costs of Iventories.

$$INV = \frac{Q}{2} \times \left(1 - \frac{P}{m}\right) \tag{11}$$

where: INV – Average Inventory Level.

Example 2. Maximum demand, $P = 2\,500\,000$ kg, $m = 10\,000\,000$ kg annualy. $WACC = k = 15\%$, $C = 25\%$, $T = 19\%$. $K_z = 12\,000$ \$, $v = 0{,}8$ \$.

First we estimate POQ:

$$POQ = \sqrt{\frac{2 \times 12\,000 \times 2\,500}{800 \times 0{,}25 \times \left(1 - \frac{2\,500}{10\,000}\right)}} = 633 \text{ (1000) kg.}$$

$$TCI_{633} = \frac{633}{2} \times \left(1 - \frac{2\,500}{10\,000}\right) \times 800 \times 0{,}25 + \frac{2\,500}{633} \times 12\,000 = 94\,868 \text{ \$.}$$

$$INV_{633} = \frac{633}{2} \times \left(1 - \frac{2\,500}{10\,000}\right) = 237 \text{ (1000) kg} \Rightarrow 237 \times 800 = 189\,600 \text{ \$.}$$

Next, we check how on firm value will influence change of production quantity to 90% POQ, $633\,000 \times 0{,}9 = 570\,000$ kg:

$$TCI_{570} = \frac{570}{2} \times \left(1 - \frac{2\,500}{10\,000}\right) \times 800 \times 0{,}25 + \frac{2\,500}{570} \times 12\,000 = 95\,382 \text{ \$,}$$

$$\frac{-\Delta FCFF_{1\ldots\infty}}{0{,}81} = \Delta TCI_{Q=633 \to Q=570} = 95\,382 - 94\,868 = 514 \text{ \$.}$$

$$INV_{570} = 800 \times INV_{570} = 800 \times \frac{570}{2} \times \left(1 - \frac{2\,500}{10\,000}\right) = 171\,000 \text{ \$,}$$

$$\Delta NWC = \left(-\Delta FCFF_0\right) = \Delta ZAP_{Q=6\,797 \to Q=30\,500} = 171\,000 - 189\,600 = -18\,600 \text{ \$.}$$

$$\Delta V_{Q=633 \to Q=570} = +18\,600 + \frac{-514 \times (1 - 0{,}19)}{0{,}15} = +15\,824 \text{ \$.}$$

As we see, if we will produce less than POQ suggest, it will create additional value. If we want to sign $VBPOQ$, we can use a table:

Table 1. *VBPOQ*

Q	TCI	Δ TCI	INV	Δ INV	Δ V
483	98 337	3 469	144 900	–44 700	25 968
482	98 391	3 523	144 600	–45 000	25 978
481	98 445	3 577	144 300	–45 300	25 984
480	98 500	3 632	144 000	–45 600	25 987
479	98 555	3 687	143 700	–45 900	25 988
478	98 612	3 744	143 400	–46 200	25 985
477	98 668	3 800	143 100	–46 500	25 980

Source: own study.

VBPOQ will be 479 000 kg. From table we see also, that costs TCI for *VBPOQ* will be greater than for *POQ*, but *VBPOQ* tie less Money in inventories what is source of benefits in alternative costs. To estimate *VBPOQ* we also could use a equation:

$$Q_{VBPOQ} = \sqrt{\frac{2 \times P \times K_z \times (1-T)}{v \times \left(1-\frac{P}{m}\right) \times [k + C \times (1-T)]}}, \quad P < m, \tag{12}$$

$$Q_{VBPOQ} = \sqrt{\frac{2 \times 2\,500 \times 12\,000 \times (1-0{,}19)}{800 \times \left(1-\frac{2\,500}{10\,000}\right) \times [0{,}15 + 0{,}25 \times (1-0{,}19)]}} = 479 \text{ (000) kg.}$$

5. Conclusion

Maximization of wealth of his owners is the basic financial aim in management of enterprise. Inventory management must contribute to realization this aim. In article we have seen value based *EOQ* model and value based *POQ* model modifications. Inventory management decisions are complex case. On one side too many money tie in inventory, burdens the enterprise with the high costs of inventory service and additionally high alternative costs. From other side, the higher inventory stock could help enlarge incomes from sales because purchasers have greater flexibility in making purchase decisions. In the article the problem connected with optimal economic order quantity and production order quantity was discussed over. Value based modifications of these two models, could help managers to make better, value creating decisions in inventory management.

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ZARZĄDZANIE ZAPASAMI UKIERUNKOWANE NA MAKSYMALIZACJĘ WARTOŚCI PRZEDSIĘBIORSTWA

Streszczenie

Podstawowym celem finansowym działania przedsiębiorstwa jest maksymalizacja bogactwa jego właścicieli. Zarządzanie zapasami powinno także przyczyniać się do realizacji tego celu. Większość funkcjonujących w literaturze modeli dotyczących zarządzania aktywami bieżącymi nie uwzględnia jednak tego celu i jest ukierunkowane na maksymalizację zysku księgowego. Niniejszy artykuł prezentuje propozycję ukierunkowanej na maksymalizację wartości przedsiębiorstwa modyfikacji dwóch najpopularniejszych w literaturze modeli do zarządzania zapasami.

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