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Financial Investment and Insurance – Global Trends and the Polish Market

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A CONCEPT OF AN INTEGRATIVE WORKING CAPITAL MANAGEMENT IN LINE WITH WEALTH MAXIMIZATION CRITERION

Summary: Typical financial models applied in the field of integrative Operating Working Capital (OWC) management assume continuous and proportionally changing to sales cash flows. This assumption is stated in order to get an elegant analytical solution to optimization problems. In real business situations, however, these flows are not continuous as the timing and magnitude of them result from batches of materials deliveries and sales. This paper improves the typical financial model as it allows for a discretionary cash flows pattern and incorporates batches of materials deliveries and sales together with delivery/ordering cycles into a wide range of decision variables available for integrated OWC management. Deterministic simulations on the financial model and application of the concurrent decision model to OWC management enable the finding of an optimal decision consistent with wealth maximization criterion.

Keywords: operating working capital, financial model of OWC, integrated OWC management, NPV.

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Theory is the most practical thing conceivable

Ludwig Boltzmann

1. Introduction

In day-to-day operations, managers have to decide on a variety of decision variables and usually they change more than one variable at once. For example, increasing the discount rate may increase the sale and, simultaneously, the requirements for inventory, both materials and finished goods, so the batch and/or the delivery cycle will change. As reported by Brigham and Gapenski [1991, p. 739], the net effect of these changes as seen from the perspective the of costs and benefits it yields is difficult to evaluate based on the modern financial theories. Therefore, financial theorists, with a few exceptions [Schiff, Lieber 1974; Lieber, Orgler 1975; Kim, Atkins 1978; Sartoris, Hill 1983; Lam, Chen 1986; Kim, Chung 1990; Chung 1990; Arcelus, Srinivasan 1993; Wędzki 2003] rarely expound on OWC management in line with wealth maximization criterion. Moreover, the tools traditionally applied in this area, like the concept of Cash Conversion Cycle, *pro forma* financial statements or cash budget (see e.g. [Brigham, Gapenski 1991; Brigham, Ehrhardt 2008; Berk, DeMarzo 2014], due to decisions criterion employed in it, may result in decisions that do not maximize company value at all. Contrary to the mainstream financial textbooks, this paper considers OWC management in light of wealth maximization criterion. The approach taken in this paper perceives investments in OWC as similar to long-term investments, and adopts methods typically applied in capital budgeting, particularly spreadsheet financial models that forecast cash flows generated by investment in OWC and NPV to value such an investment.

As already mentioned, a wealth-maximization criterion attitude to OWC management has some literary background. However, financial models, such as those developed by Schiff and Lieber [1974], Lieber and Orgler [1975], Kim and Atkins [1978], Sartoris and Hill [1983], Lam and Chen [1986], Kim and Chung [1990], Chung [1990] take an analytical approach typical of the methodology applied in theoretical and practical considerations in the finance literature from this distant period. Such typical financial models assume continuous operating cash flows generated from operations and, as such, are of little accuracy and so has more theoretical but less practical implications for OWC management. In real business situations, the operating cash flows generated from operations are not continuous as the timing and magnitude of it result from batches of materials deliveries and sales. The typical financial model is very limiting and needs improvements to better suit managerial needs. This improvement is done in this paper twofold. First, the forecasting task is separated from valuation. Second, two distinct but connected models are built: one integrates OWC management and enables the forecasting of operating cash flows resulting from investment in OWC and the other value these forecasts in line with wealth maximization criterion. This paper's aim is: (i) to build a financial model of OWC which incorporates the batches of materials delivery and sales and accompanying delivery/ordering cycles by applying the spreadsheet approach to financial modelling as described in [Charnes 2007] and (ii) to build a decision model based on NPV to value investment in OWC under wealth maximization criterion following the general valuation model, as previously applied in the field of OWC management by [Sartoris, Hill 1983].

It is hypothesized in the paper that an integrative OWC management under an investment approach allows for the managing of OWC in line with wealth maximization criterion. An investment approach means that investments in OWC are operationalized in the cash flows workshop thus giving the possibility to perceive these investments as an asset generating a sequence of consecutive operating cash inflows and outflows. An integrative OWC management means that the main components of OWC (operating cash, accounts receivable, inventories and operating current liabilities) and a variety of decision variables, e.g. sales prices, materials and labor prices, trade credit terms received and granted, or salary deferral period are integrated into one financial model of OWC. As a result, if changes of one or more decision variables simultaneously alter other decision variable(s), the final net result may be observed in the operating cash outflows and cash inflows resulting from investments in OWC. These cash flows are then evaluated by NPV rules consistent with wealth maximization criterion (Figure 1).

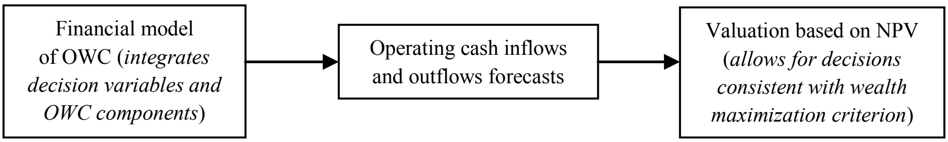


Figure 1. An integrative OWC management in line with wealth maximization criterion

Source: own elaboration.

The paper is organized as follows: The second part consists of a brief review of literature on both the integrative approach to OWC management and the development of the decision criterion. The third part explains the fundamental differences between a typical financial model assuming continuous cash flows from sales, and a financial model developed in the paper allowing for discretionary cash flow patterns resulting from batches of material deliveries and sales. The fourth part is a proposal of two models: (i) a financial model of OWC that integrates OWC management and allows for discretionary cash flows patterns and (ii) a decision model based on NPV criterion that enables managers to take decisions in line with wealth maximization criterion. The part devoted to the decision model is, for simplicity, divided into sections: (A) assuming constant demand and (B) allowing for discretionary demand. The theoretical considerations are followed with examples of applications and a simple case study in section five. This section takes a first look at the problem of optimization of OWC management: the task solved by deterministic simulations is the optimal delivery cycle. Finally, section six explains the advantages of the concept disclosed in the paper, comparing it with other tools applied in the field of OWC management. Ending part consists of conclusions and signs for future research.

2. Literature review

The review of the relevant literature on OWC management reveals at least two joint processes within it currently existing in the state of financial art: the first is the OWC management integration and the second is the decision criterion development. It is worth mentioning, however, that these approaches dominate in journals while the text-book literature seems to be far behind it. As a result, seminal papers have not been popularized and so far, to the best of my knowledge, do not have many proponents. In Poland, attempts were made by Wędzki [2000] and Rutkowski [2000], but only refer to the management of accounts receivable. Wędzki [2003] applies a concept of residual income to value the working capital management strategy, still he values the strategy on the basis of data available from financial statements. In general, however, OWC management over the last 50 years has been assigned almost solely to financial liquidity management and theoretical as well as empirical research has been conducted mainly in this area. Even the concept of the Cash Conversion Cycle [Richards, Laughlin 1980] being today a basic tool to assign the OWC management efficiency was initially designed to control for financial liquidity in on-going concern. Liquidity oriented OWC management has probably held back the somehow obvious relation that effective OWC management is a source of wealth to company stakeholders.

2.1. OWC management integration

Integration of OWC management means that all its components as well as decision variables are included in one financial model so there is a possibility to observe and measure trade-offs between benefits and costs the decisions produce. Integration succeeds after the extended period of compartmentalization of OWC management relevant to its components: operating cash, accounts receivable, inventories and operating current liabilities (accounts payable and accruals). It happened due to obvious connections between each of these components lasting in a strict relationship: they are all simultaneously employed in the company operating cycle. Usually, change in one variable alters the remaining. Furthermore, in the light of Goldratt's theory of sub-optimization of constraints, it is justified to argue that the separate management of OWC components is inefficient even though optimization within one OWC component is connected with homogeneity for the entire company goal function.

In the wealth maximization stream, the integration of working capital management starts from accounts receivable management which includes a lot of decision variables [Schiff, Lieber 1974; Lieber, Orgler 1975], then moves to inventory and accounts receivable integration [Kim, Chung 1990] and finally integrates all working capital management components [Sartoris, Hill 1983; Arcelus, Srinivasan 1993]. So far, decision variables included in the financial models consist of: trade credit terms both granted and received, discount rate, prices: sales, materials, inventory carrying and shipping costs, the delay of salary payments, penalty charges for late payments, rate on overdue payment from collection agencies and time the company decides on selling overdue balances, limits of materials consumption and delivery batch. This list was extended by advanced payments, labor cost and the salary deferral period by [Szpulak 2015]. So far, all models are built under assumption of continuous cash flows resulting from sales.

2.2. OWC management decision criterion

Although net investments in OWC are conceptually similar to long-term investment decisions, the financial theorists reviewed below, with a few exceptions, rarely expound on OWC management in line with wealth maximization criterion. This gap is clearly seen when studying financial textbooks (see e.g. [Brigham, Gapenski 1991; Brigham, Ehrhardt 2008]) where tools like financial ratios, the concept of Cash Conversion Cycle or cash budget are recommended.[1]

The traditional decision criterion in the field of OWC management was adopted from inventory management and thus based on cost minimization (e.g. [Miller, Orr 1966; Merville, Tavis 1973]), however, as the financial theories developed and started to operate in the cash flows the traditional cost minimization criterion appears as less effective [Kim, Chung 1990]. It occurs mainly due to the fact that OWC management highly influences the demand for the product and thus boosts the revenues. Changing revenues abolishes the main assumption under which cost minimization and net income maximization criterions are equivalent.

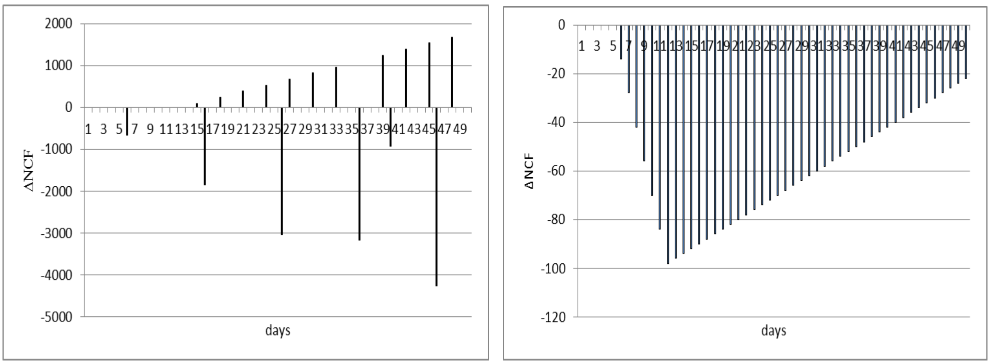
Foundation papers of Schiff and Lieber [1974] and Lieber and Orgler [1975] base the NPV decision on accounting profits so they do not operate in the cash flow framework opposite to [Kim, Atkins 1978] who moved the considerations into the discounted cash flow framework. Following [Kim, Atkins 1978], the considerations of Sartoris and Hill [1983], and Kim and Chung [1990] on working capital management are embedded in the discounted operating cash flow framework, while Arcelus and Srinivasan [1993] use more general discounted Free Cash Flows. Attempts to incorporate uncertainty in the OWC management under wealth maximization criterion can also be found. Papers by Lam and Chen [1986] and Chung [1990] employ a contingent claims approach to value investments in accounts receivable and inventories within stochastic the discounted cash flows workshop.

3. Foundations of financial models applied in OWC management

Financial models constructed in the papers mentioned above have at least a few common features. As all are intended to show analytical solutions, they swell with limitations imposed on variables and restrictions of their applications. Some assume

[1] For more extensive review of traditional tools recommended in the standard financial textbooks see [Szpulak 2014].

production at a uniform rate [Kim, Chung 1990] or continuous cash outflows and inflows resulting from sales [Sartoris, Hill 1983; Kim, Chung 1990]. Others reduce their applications to one business activity [Arcelus, Srinivasan 1993]. This is due to obvious complications that arise when we wish to model true business situations. On the other hand, we can see models that simplify the business situation so much that it is almost impossible to meet such a case in reality, like the assumption of infinite constant value increments made by [Michalski 2014, p. 9, 25]. It seems that these disadvantages of analytical solutions may be overwhelmed by simulations. Fundamental to the simulation approach is the financial model that mimics the real business situation, and may be used to simulate real processes. Such an analysis of the financial phenomenon under considerations may give additional insights and clearly show how far from reality the current state of the art is. In my previous work [Szpulak 2011] I have built a financial model of OWC which fairly accurately enables the simulation of its processes and then observes its evolution on a cash flow basis as well as under accrual accounting. The two graphs below show the simulated series of 50 daily net cash flows. A series depicted on the graph in part (a) of Figure 2 is generated by my model which allows for free cash inflows and outflows pattern, while the series depicted on the graph in part (b) of Figure 1 is generated by a typical model that assumes continuous cash outflows and inflows resulting from sales (as in [Kim, Chung 1990; Sartoris, Hill 1983; Szpulak 2014]). For consistency, both series are simulated under the assumption of constant increments in demand (however in my model, demand may be represented by discretionary values) and equal OWC decision variables such as the period of trade credit granted and received, price of sales unit, price of materials unit, unit labour costs and unit materials consumption.



(a) (b)

Figure 2. Simulated series of net cash flows resulting from 50 days of operations under linear demand in panel (a) assuming a discretionary cash flows pattern and (b) assuming continuous cash inflows and outflows resulting from sales

Source: own composition.

The differences between the two series are formidable and occur not only in the timing but as well in magnitude and the sign of the simulated NCF being crucial for NPV measure.[2] It is also obvious that the decision criterion developed under assumption of continuous cash outflows and inflows fails in real business situations. In practice, cash inflows and outflows are strictly connected with batches of materials deliveries and sales. This means that, in particular, the magnitude and timing of outflows and inflows depend not only on the length of trade credit granted and received but also on the delivery cycle and ordering cycle being essential for OWC management. The section below introduces a financial model of OWC and decision criterion that refer to batches of materials delivery and sales abolishing the assumption on continuous cash inflows and outflows resulting from sales.

4. The models proposition

4.1. Financial model of OWC

Let us assume that the company has the following decision variables: credit term granted T^{AR}; credit term received T^{AP}; materials delivery ordering cycle T^{D}; sales ordering cycle T^{O}; unit sales price p_s; unit materials consumption m; and unit materials price p_m. The company operates under the assumption of a fixed delivery cycle, its operating cycle consists of purchasing – production – sales – collection and is partially and spontaneously financed by accounts payable. Cash flows associated with these operating and financing cycles are operating cash inflows CF^{+} and operating cash outflows CF^{-} (see Figure 3). Both cash flows CF^{+} and CF^{-} appear at

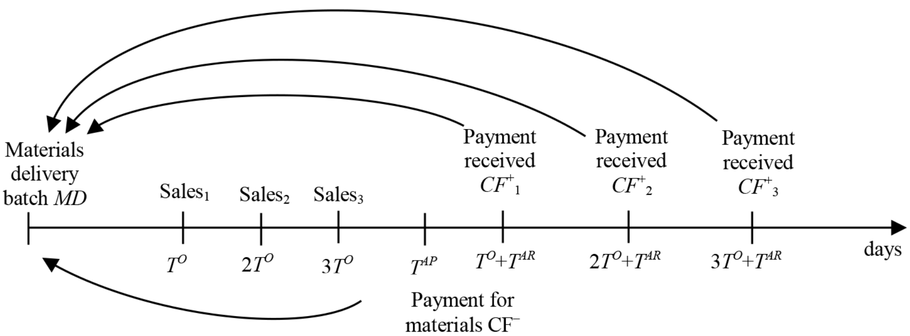


Figure 3. An example of cash flow timeline

Source: own composition.

[2] NPV for both series under 10% rate p.a. equals –4400 PLN and –3800 PLN respectively.

the end of the trade credits periods T^{AR} and T^{AP} respectively as it is not economically justified to settle accounts earlier. Arrows on Figure 3 indicate that all cash inflows and outflows are assigned to one materials delivery batch. The structure of the model is depicted in Figure 4.

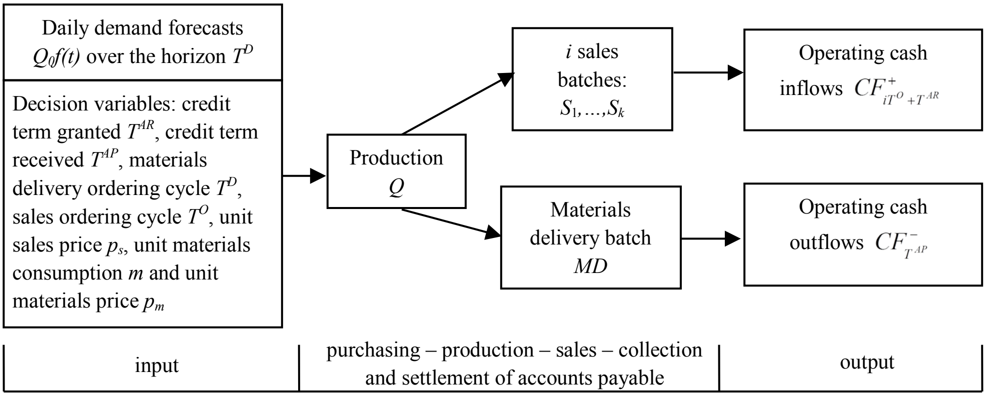


Figure 4. Financial model of OWC

Source: own composition.

For practical reason it is assumed that $T^D = kT^0$. It means that company plans production and materials delivery based on k consecutive sales orders,[3] therefore after receiving k orders sets production batch in amount of Q and orders materials batch in amount of MD required to produce it.

During the period of T^D days, a company produces Q units:

$$Q = \int_{1}^{T^D} Q_0 f(t)dt, \tag{4.1}$$

where: T^D – materials delivery ordering cycle; $Q_0f(t)$ – daily demand trend function.

The materials delivery batch MD is based on forecast of daily demand for company products and equals:

[3] In practice materials delivery ordering cycle T^D and sales ordering cycle T^O need not to be related, particularly when more than one type of material and other operating costs like salaries are included into analysis. However, inclusion of these additional parameters into model confounds the consideration and, in my opinion, hampers readers to get the gist of the concept presented in the paper, therefore for practical reason the assumption relating T^D and T^O is introduced. For extended version of financial model of OWC free of such assumption see [Szpulak 2014].

$$MD = \int_{1}^{T^D} m \cdot Q_0 f(t)d, \tag{4.2}$$

where: MD – materials delivery; m – unit materials consumption.

The final product is sold in i (i = 1,..., k) sales batches S_i and its occurrence depends on ordering cycle T^O:

$$S_i = \int_{(i-1)T^O+1}^{iT^O} Q_0 f(t)dt \tag{4.3}$$

such that $Q = \sum_{i=1}^{k} S_i$.

Cash outflows and inflows arise from materials delivery batches and sales batches. Cash outflow CF^- resulting from materials delivery batch MD occurs on T^{AP} day of operating cycle and equals:

$$CF^-_{T^{AP}} = MD \cdot p_m, \tag{4.4}$$

where: p_m – unit materials price; T^{AP} – trade credit period received.

Cash inflows occur at every $iT^O + T^{AR}$ day of company operating cycle and equals:

$$CF^+_{iT^O+T^{AR}} = S_i \cdot p_s, \tag{4.5}$$

where: p_s – unit sales price; T^O – ordering cycle; T^{AR} – trade credit period granted.

All formulas from (4.1) to (4.5) are transformed into adequate Excel functions and a spreadsheet financial model is built.[4] Such a spreadsheet financial model is a subject of simulations made under different input variables. Examples of the results of such simulations are presented in the paper in section 5 in tabular form (see Table 1) and in graphical form (see Figures 5–7).

4.2. Decision model

A. Horizontal pattern

The model developed in this section has more of a pragmatic meaning for managers and students because it easily captures the core idea employed for decision-making purposes. Assuming that the demand is known with certainty and constant over the whole planning horizon T cash flows for any operating cycle CF^+

[4] Spreadsheet financial model built in Excel applied through this article is available from the author upon request.

and CF^{-} follow the same pattern. This pattern is designed by working capital decision variables including periods: T^{D}, T^{O}, T^{AR} and T^{AP} as well as p_s, p_m and m and is fully characterized by timing and magnitude of cash flows. Graphs in Figure 5 display a series of cash flows generated through simulations by spreadsheet financial model described by equations (4.1)–(4.5).

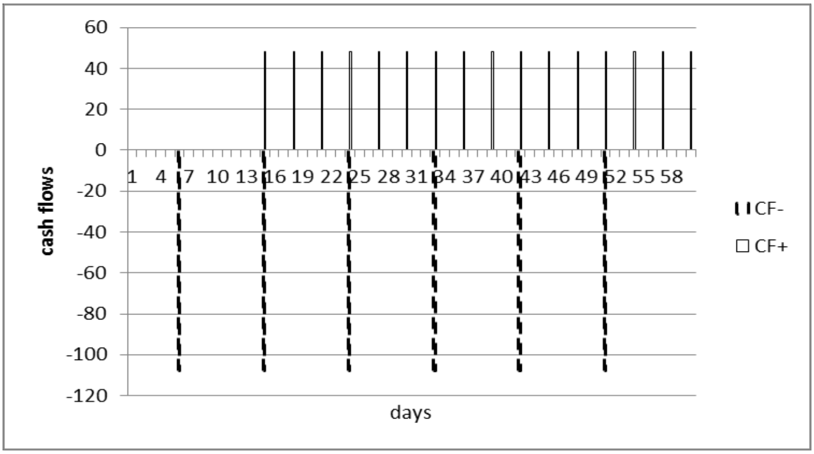


Figure 5. Simulated cash flows pattern assuming constant demand

Source: own composition.

Such a cash flow pattern does not change over time, so for managerial purposes it is enough to evaluate investments in one typical operating cycle. The valuation formula based on NPV discounts cash flows on the day before materials delivery takes place ($t = 0$):

$$NPV = -\frac{CF^{-}_{T^{AP}}}{(1+r)^{T^{AP}}} + \sum_{i=1}^{k} \frac{CF^{+}_{iT^{O}+T^{AR}}}{(1+r)^{iT^{O}+T^{AR}}}\,, \tag{4.6}$$

where: r –the project's risk-adjusted cost of capital.

Changes in the working capital policy decision variables (model parameters) T^{O}, T^{D}, T^{AR}, T^{AP}, p_s, p_m and m to T^{O}', T^{D}', T^{AR}', T^{AP}', p_s', p_m', and m' should be accepted only in such a situation when new NPV' exceeds the previous NPV:

$$NPV' - NPV > 0. \tag{4.7}$$

Consider together: the financial model of OWC, valuation formula in (4.6) and decision criterion in (4.7) creates a procedure employed for decision making within a concept of integrative OWC management in line with wealth maximization criterion. The scheme presented in Figure 6 is a graphical presentation for an applied pro-

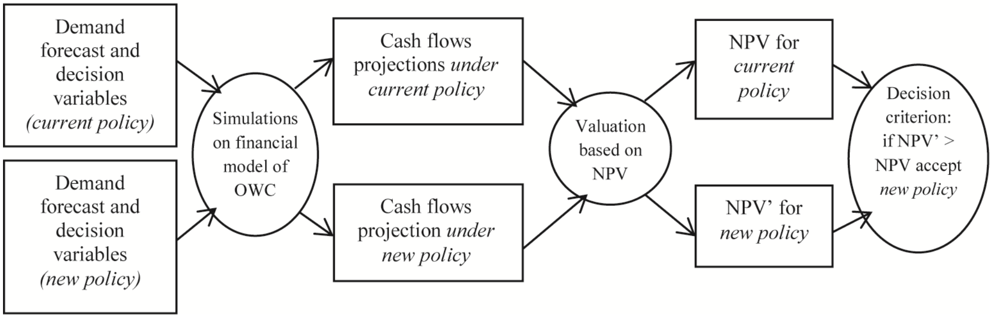


Figure 6. Procedure employed within integrative OWC management in line with wealth maximization criterion

Source: own composition.

cedure. It must be mentioned, however, that if we have more than one option because of a different set of demand forecast and decision variables, the NPV valuation formula allows for the ordering of all options from less favorable to the most favorable.

Example 4.1.

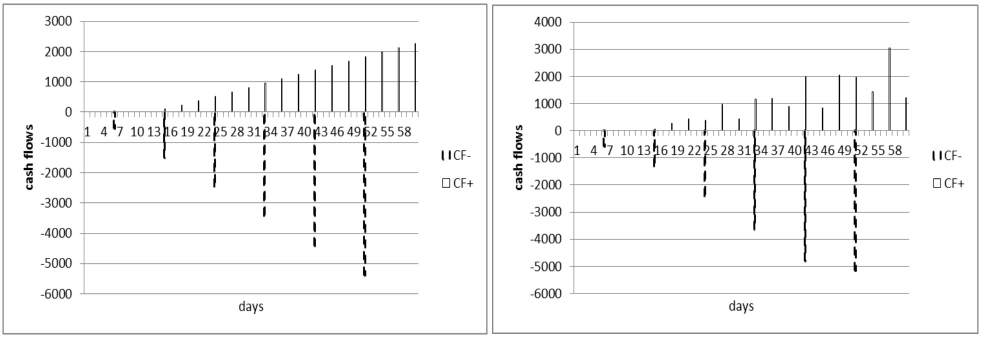
Company managers set the following values for OWC decision variables: $T^O = 3$, $T^D = 9$, $T^{AP} = 6$, $T^{AR} = 15$, $m = 2$, $p_s = 8$, $p_m = 3$. Discount rate under certainty cash flows equals to risk free rate r = 3% p.a. The demand during the planning horizon is forecasted at a constant level 2 units a day. Applying directly the formulas from (4.1) to (4.5) we will get: $MD = 36$, $Q = 18$, $S_1 = 6$, $S_2 = 6$, $S_3 = 6$, $CF^-_6 = 108$, $CF^+_{18} = 48$, $CF^+_{21} = 48$, $CF^+_{24} = 48$. According to (4.6), the NPV equals:

$$NPV = -\frac{108}{(1+0.03/365)^6} + \frac{48}{(1+0.03/365)^{18}} + \frac{48}{(1+0.03/365)^{21}} + \frac{48}{(1+0.03/365)^{24}} = 35.80 \text{ zł}$$

Managers consider (i) lengthening the trade credit period from 15 to 20 days, which in turn may stimulate the sales to 3 units a day, or (ii) they think of a 10% reduction in sales price, which may result in an increase in sales from 2 to 4 units a day. Recalculating (4.1) to (4.5) and NPV formula given in (4.6) we will get $NPV^{(i)}$ = 53.62 zł and $NPV^{(ii)}$ = 42.86 zł. The result indicates that the net effect of changes in OWC policy is more valuable to company investors in the case of the first option than the second, so managers should choose the first one.

A. Discretionary time series pattern

As demand is rarely constant over the planning horizon T, it is more realistic to assume that it follows a time pattern: $f(t)$. It can be time pattern of any type including seasonal variations and the demand time pattern can freely change over time. Even though we still assume the demand time pattern and its possible changes are known with certainty. In such circumstances, cash flows CF^+ and CF^- are functions of the demand time pattern and cash flows pattern properties are generated from both: working capital policy defined by T^O, T^D, T^{AP}, T^{AR}, p_s, p_m and m and demand time pattern. The graph in Figure 7 displays a series of cash flows generated by a spreadsheet financial model.



(a) (b)

Figure 7. Simulated cash flows pattern assuming a linear trend in (a) and weekly seasonal variations over a linear trend in (b)

Source: own composition.

At this stage of the analysis, each operating cycle cash flow may differ due to demand time pattern and its changes, and it is required to evaluate investments in working capital over the whole planning period T. Throughout the planning period T, a company places materials orders every TD days realizing $j = 1, \ldots, n$ materials delivery MD_j. To value the investment in OWC over the whole planning period, the following valuation formula may be applied:

$$NPV = \sum_{j=1}^{n} \frac{NPV_{(j-1)T^D}}{(1+r)^{(j-1)T^D}}, \tag{4.8}$$

where:

$$NPV_{(j-1)T^D} = -\frac{CF^-_{T^{AP}+(j-1)T^D}}{(1+r)^{T^{AP}+(j-1)T^D}} + \sum_{i=1}^{k} \frac{CF^+_{j(iT^O+T^{AR})}}{(1+r)^{j(iT^O+T^{AR})}}. \tag{4.9}$$

Any changes in the working capital decision variables (model parameters) T^O, T^D, T^{AR}, T^{AP}, p_s, p_m and m to T^{O}', T^{D}', T^{AR}', T^{AP}', p_s', p_m', and m' should be accepted only if condition (4.7) holds. An example of application of this valuation formula is presented in the next section.

5. Application of the concept for optimization of OWC management

The concept of an integrative OWC management in line with wealth maximization criterion presented in the paper is designed to capture all trade-offs between potential benefits and costs of introducing a new working capital policy. From the perspective of company investors, it is vital that decisions not only increase, but also maximize their wealth. The decisions that increase the wealth were presented in the previous section, while in this section the goal is to design a working capital policy that will satisfy wealth maximization criterion. The tool used is a simulation on the spreadsheet financial model given by equations (4.1) to (4.5). The case presented in this section refers to a real business problem – a medium size company that operates on the dairy market in Poland. The problem that concerns managers is the length of the materials delivery cycle T^D.

The current company OWC policy consists of T^{AR} = 15 days, T^{AP} = 6 days, p_s = 8, p_m = 1, m = 1, T^O = 3 days. Inventory carrying costs amount to 12% of materials delivery and are paid 30 days later. Fixed shipping costs are set at 50 for batches equal to 700 units paid on the 6th day. The company observes weekly seasonal variations in sales. The planning period range is 54 days. The cost of capital equals 30%.

To find the optimal value of the delivery cycle, the model given by equation (4.9) is operationalized as follows:

$$NPV_{(j-1)T^D} = -\frac{CF^-_{T^{AP}+(j-1)T^D} + xF}{(1+r)^{T^{AP}+(j-1)T^D}} - \frac{h\cdot p_m \cdot MD_{1+(j-1)T^D}}{(1+r)^{T^C+(j-1)T^D}} + \sum_{i=1}^{k}\frac{CF^+_{j(iT^O+T^{AR})}}{(1+r)^{j(iT^O+T^{AR})}} \tag{5.1}$$

where: F – fixed shipping costs; x – # of shipments; h – inventory carrying costs as a rate; T^C – carrying costs payment deferral period.

Given the condition $Q=\sum_{i=1}^{k} S_i$ the possible T^D length is 3, 6, 9, 12, 15, … days.

For every possible length the $NPV_{(j-1)T^D}$ defined in (5.1) and NPV defined in (4.8) are calculated. Table 1 consists of a part of calculations for T^D = 3 while Table 2 presents the results depicted on the graph next to it.

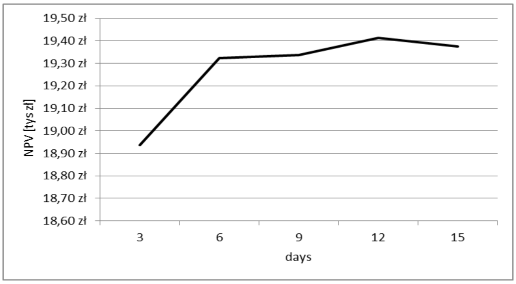
Table 1. A part of *NPV* calculations for T^D = 3 days

t	j	i	$Q_0f(t)$ [unit]	MD_j [zl]	hp_mMD_j [zl]	F [zl]	S_i [unit]	CF_t^- $+xF$ [zl]	CF_t^- (hp_mMD_j) [zl]	CF_t+ [zl]	NPV_j [zl]
1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	0.6	7.6	0.912	50	0	0	0	0	1.700921
2	1	1	1.6		0	0	0	0	0	0	0
3	1	1	5.4		0	0	7.6	0	0	0	0
4	2	1	15.2	33.8	4.056	50	0	0	0	0	179.0854
5	2	1	15		0	0	0	0	0	0	0
6	2	1	3.6		0	0	33.8	57.6	0	0	0
7	3	1	5.6	54.2	6.504	50	0	0	0	0	317.2016
8	3	1	14.4		0	0	0	0	0	0	0
9	3	1	34.2		0	0	54.2	83.8	0	0	0
10	4	1	30	46.2	5.544	50	0	0	0	0	263.0384
11	4	1	6.6		0	0	0	0	0	0	0
12	4	1	9.6		0	0	46.2	104.2	0	0	0
13	5	1	23.4	121.6	14.592	50	0	0	0	0	773.5267
14	5	1	53.2		0	0	0	0	0	0	0
15	5	1	45		0	0	121.6	96.2	0	0	0
16	6	1	9.6	55.6	6.672	50	0	0	0	0	326.6802
17	6	1	13.6		0	0	0	0	0	0	0
18	6	1	32.4		0	0	55.6	171.6	0	60.8	0
19	7	1	72.2	144.8	17.376	50	0	0	0	0	930.6001
20	7	1	60		0	0	0	0	0	0	0
21	7	1	12.6		0	0	144.8	105.6	0	270.4	0
22	8	1	17.6	150.2	18.024	50	0	0	0	0	967.1602
23	8	1	41.4		0	0	0	0	0	0	0
24	8	1	91.2		0	0	150.2	194.8	0	433.6	0
25	9	1	75	112.2	13.464	50	0	0	0	0	709.885
26	9	1	15.6		0	0	0	0	0	0	0
27	9	1	21.6		0	0	112.2	200.2	0	369.6	0
28	10	1	50.4	250.6	30.072	50	0	0	0	0	1646.909
29	10	1	110.2		0	0	0	0	0	0	0
30	10	1	90		0	0	250.6	162.2	0.912	972.8	0
31	11	1	18.6	103.6	12.432	50	0	0	0	0	651.6595
32	11	1	25.6		0	0	0	0	0	0	0
33	11	1	59.4		0	0	103.6	300.6	4.056	444.8	0

Source: own calculations.

Table 2. A comparison of NPVs for different values of T^D.

T^D	*NPV*
3	18 936.94 zł
6	19 322.98 zł
9	19 335.71 zł
12	19 414.06 zł
15	19 375.78 zł



Source: own calculations.

The results indicate that managers should decide on a delivery cycle of 12 days to satisfy wealth maximization criterion.

6. The advantages of the suggested concept over the current state of financial art

- *The concept indicates that effective investments in OWC are a source of wealth to company stakeholders*

Apart from a few vague statements concerning the relation between OWC management and wealth maximization criterion based on the concept of Cash Conversion Cycle (the shorter the CCC, the more wealth is created) and firm valuation formula (the lower are investments in OWC, the higher are FCF) that exist in the financial literature [e.g. Brigham, Ehrhardt 2008, p. 775; Berk, DeMarzo 2014, p. 889] managers are instructed to insist on minimizing stocks of operating current assets. Shortening the cash conversion cycle and reducing investments in OWC is a source of wealth unless the sales are not reduced or/and costs are not raised. In practice, this particular advice reduces the possible actions managers can take to one relying on reducing alternative costs the company has due to inefficient OWC management, particularly that the additional free cash flows are gained by improving processes such as purchasing or production. Ultimately, however, no company can operate without the necessary stocks to maintain its operations. Does it mean that companies which manage OWC efficiently (i.e. has the minimum possible level of operating current assets) has no other possibility to create wealth in the short-term? The point is that in the approach taken in this paper, managers may design an OWC management policy, which boosts operating net cash flows without needing to reduce stocks, for example by lengthening the trade credit period T^{AR}. The question is, is it worth to do so, comparing the alternative investment of equivalent risk? *NPV* is a proper measure, which introduces the opportunity cost of capital into the analysis, which is thus far absent in the CCC. Effective investments in OWC in this paper are defined as giving additional wealth to company stakeholders by the criterion of *NPV*.

- *The concept integrates OWC management*

Integration of OWC management, as defined in this paper, relays on integrating OWC components and decision variables done to catch relationship between them. Changing one variable results in changes of other variables, like e.g. lengthening trade credit period T^{AR} results in sales increase, and ultimately, changes the delivery cycle T^{D}, ordering cycle T^{O} and/or delivery batch (both: *MD* and *S*). The concept enables to analyze such relationships and measure the resulting trade-offs, all subject to one common for entire company goal – the stakeholders' wealth maximization.

- *The concept links short-term financial goals with the long-term ones*

As financiers state, one of the factors causing the last financial crisis is the dispersion between short-term objectives and long-term ones. So far, in the field of OWC management, managers are not well equipped with the tools necessary to manage OWC consistently with long-term objectives of maximizing company value. Calculating FCF requires *pro forma* financial statements, created at the end of the accounting period while short-term horizon reaches much shorter periods. The concept presented here adopts to the short-term horizon well established end effective tools for capital budgeting, i.e. the spreadsheet approach to financial modelling and *NPV* to valuing investments in OWC. With the adoption of the approach taken in the paper, short-term goals and long-term ones are expressed in the same manner.

- *The concept separates financial decisions from investment decisions*

The financial literature advises the assessment of the efficiency of OWC management on the basis of *pro forma* financial statements. Some financial theorists adopt opportunity costs account [Brigham, Gapenski 1991, p. 830–832], others Economic Value Added [Wędzki 2003, p. 259–316] both however require much more information than is needed to decide on an OWC management policy in the approach taken in this paper. To see the difference, as an example we will solve the case of Monroe Manufacturing presented by Brigham and Gapenski [1991, p. 830–832]. The authors applied the opportunity costs account and *pro forma* financial statement to decide on whether to adopt a new accounts receivable policy.

Monroe Manufacturing current accounts receivable policy consists of 1/10, net 30. 50% of customers use discount, 40% pay within trade credit period and remaining 10% pay late on average 40th day. The company spends $5m USD a year to collect balances and 2.5% of sales are bad debts (this amounts to 25% of late payments[5]). Credit sales at the end of the year amount to $400m USD, production costs to $280m and the cost of capital equals 20%.

[5] $b\lambda = 0.025S$, $\lambda = 0.1$, $b = 0.25$.

Under a new, more relaxed policy, the condition of 2/10, net 40 and less collection efforts are considered. The forecasted results indicate that 60% of customers will use discount, 20% will pay on 40th day and remaining 20% constitute late payments. Lesser collection efforts will decrease collection costs to \$2m a year and increase the portion of bad debts to 6% of sales (this amount to 30% of late payments). Easing the credit policy will stimulate credit sales to \$530m at the end of the year and production costs to \$371m. The cost of capital remains at the 20% level.

In the case of Monroe Manufacturing, a few additional decision variables for the valuation formula (4.6) are added. These are: discount offered to customers for early payment, late payments and bad debts. The valuation formula given in (4.6) is thus:

$$NPV = -\frac{CF^{-}_{T^{AP}}}{(1+r)^{T^{AP}}} + \sum_{i=1}^{k} \frac{q(1-d)CF^{+}_{iT^{O}+T^{ARd}}}{(1+r)^{iT^{O}+T^{ARd}}} + \sum_{i=1}^{k} \frac{(1-q-\lambda)CF^{+}_{iT^{O}+T^{AR}}}{(1+r)^{iT^{O}+T^{AR}}} + \\ + \sum_{i=1}^{k} \frac{(1-b)\lambda CF^{+}_{iT^{O}+T^{LATE}}}{(1+r)^{iT^{O}+T^{LATE}}} \qquad (6.1)$$

where: d – discount rate for early payment; q – portion of cash inflows from sales relevant to customers using a cash discount; T^{ARd} – trade credit period relevant to discount for early payment; λ – portion of credit sales relevant to customers paying late; b – bad debts as a portion of late payments; T^{LATE} – maximum time period company collects its balances.

As formulas presented in the paper work on daily basis, the aggregated values need to be expressed as so. Assuming that the daily sales equals S/365 and total costs TC/365 the corresponding inflow and outflow respectively would be the same. Parameters not mentioned in the case may be treated as irrelevant – like the trade credit period used by Monroe Manufacturing or the rules of settling collection costs. This is because the decision criterion in (4.7) relies on increments in NPV values, not the values themselves.

The model (6.1) operationalized to the conditions of the Monroe Manufacturing case takes the following form:

$$NPV = -TC/365 + \frac{q(1-d)(S/365)}{(1+r)^{T^{ARd}}} + \frac{(1-q-\lambda)(S/365)}{(1+r)^{T^{AR}}} + \\ \frac{(1-b)\lambda(S/365)}{(1+r)^{T^{LATE}}} \qquad (6.2)$$

where: TC – production and collection costs; S – annual sales.

The NPV given in (4.11) under conditions of current policy equals [mln USD]:

$$NPV = -285/365 + \frac{0.5 \cdot (1-0.01) \cdot (400/365)}{(1+0.2/365)^{10}} + \frac{0.4 \cdot (400/365)}{(1+0.2/365)^{30}} + \\ + \frac{(1-0.25) \cdot 0.1 \cdot (400/365)}{(1+0.2/365)^{40}} = 0.27$$

while under conditions of new policy [mln USD]:

$$NPV' = -373/365 + \frac{0.6 \cdot (1-0.02) \cdot (530/365)}{(1+0.2/365)^{10}} + \frac{0.2 \cdot (530/365)}{(1+0.2/365)^{30}} + \\ + \frac{(1-0.30) \cdot 0.2 \cdot (530/365)}{(1+0.2/365)^{40}} = 0.31$$

As *NPV'* – NPV is more than 0, a new policy should be accepted. The result is consistent with the result gained by Brigham and Gapenski. Based on a *pro forma* income statement, they argue in favor of the new credit policy.[6] Regardless of the result, the time devoted to get the result is by no means lower with the model (6.2) than with opportunity cost account and *pro forma* financial statement.

- *The concept enables risk analysis*

Although the considerations made through the paper are done under certainty, the integrative and investment approach taken to OWC management enables risk analysis. Decisions taken within OWC management highly influence the risk of operating cash flows, for example, extending the trade credit period usually increases risk of operating cash flows. Thus, the risk-adjusted rate of return, as a discount factor included in the decision model, enables managers to consider risk in valuing investment decisions in OWC. The point is that the financial model of OWC instead of one certain future value of operating net cash flows with the application of the simulations may generate a distribution of such operating net cash flows. Having the distribution, we may measure the risk; next, we may price the risk on the financial market and finally in this way incorporate the risk into OWC management. We may as well treat this different OWC policy as an option and apply option-pricing theory to manage OWC under uncertainty. A few attempts have already been taken by [Lam, Chen 1986; Chung 1990] but not in the integrated approach to OWC management.

- *The concept creates investment project viable in terms of financial liquidity*

In traditional approach to capital budgeting to control for financial liquidity of investment project the additions to OWC are taken into account. This, however, does not guarantee the financial liquidity. Referring to the financial model of OWC, OWC generates operating cash inflows and outflows. These flows are not the sole reported

[6] EBIT = 0.32 m USD, EBIT' = 0.43 m USD.

in the company cash flows statement. Financial liquidity is a broader concept, as it includes flows generated by investment and financing decisions. However, as financial theorists say [Stone, Wood 1977], flows generated on operating activity are crucial for financial liquidity. The concept enables the control of financial liquidity as it works on cash flows, and therefore links the investment. Cash investments required for OWC occur at the time T^{AP} and amounts to CF^{-}. This amount ought to be delivered by company investors, and if not, the company is unable to control financial liquidity.

- *The concept is easy, adopts well known tools and is very flexible*

The most prominent feature of the approach presented in the paper is the ease and flexibility of it. The model described by equations (4.1) to (4.5) may be easily adapted to particular business situations and additional working capital decision variables may be added to the model. Altogether, it may draw managers' attention to the fact that there is not such a sophisticated way to manage OWC in line with wealth maximization criterion.

7. Conclusions

The goal of this paper was (i) to build a financial model of OWC that allows for discretionary cash flows pattern because it incorporates the batches of materials delivery and sales and accompanying delivery/ordering cycles into integrated OWC management and (ii) to build a decision model that enables decisions to be made within OWC management, consistent with wealth maximization criterion. For this purpose the traditional financial model was improved by (i) separating the forecasting task from valuation, (ii) adopting a spreadsheet approach to financial modelling, (iii) integrating OWC management by including OWC decision variables and OWC components in one financial model and (iv) applying a general valuation model to value investments in OWC on the basis of series of net cash flows such investments generate over the entire planning period. The first attempt at the optimization of OWC management was made.

Examples, application of a concept to optimise the length of materials delivery cycle and advantages listed in section 6 support the hypothesis stated in the introduction and justify the final conclusion that the integrative and investment approach to OWC management links the short term financial management with the wealth maximization criterion. The improvements made in the paper to the typical financial model of OWC have abolished the unreal assumption of continuous cash flows generating from operations and therefore diminished financial model errors making the cash flows forecasts of better quality to managers. However, an employed workshop needs to be extended including the possibility of optimization of more than one decision variable and rather stochastic than deterministic simulations. These are the steps for future research.

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KONCEPCJA ZINTEGROWANEGO ZARZĄDZANIA OPERACYJNYM KAPITAŁEM PRACUJĄCYM W WARUNKACH MAKSYMALIZACJI BOGACTWA INWESTORÓW

Streszczenie: Tradycyjny model finsowy stosowany w obszarze zintegrowanego zarządzania operacyjnym kapitałem pracującum (OWC) zakłada ciągłe i proporcjonalne przepływy pieniężne generowane ze sprzedaży. Założenie to przyjmuje się w celu uzyskania zgrabnego analitycznego rozwiązania problemu optymalizacji zarządzania OWC. W praktyce jednak przepływy pieniężne nie są ciągłe, a momenty ich występowania i ich wielkość zależą bezpośrednio od partii zamówionych materiałów i sprzedaży. W artykule udoskonalono typowy model decyzyjny, włączając rozmiary partii i towarzyszące im cykle dostaw do zintegrowanego zarządzania OWC. Symulacje deterministyczne na modelu finansowym i przy zastosowaniu modelu decyzyjnego pozwalają na optymalizację zarządzania OWC w świetle kryterium maksymalizacji bogactwa inwestorów przedsiębiorstwa.

Słowa kluczowe: opracyjny kapitał pracujący, finansowy model OWC, NPV, wartość przedsiębiorstwa.