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CASH AND WORKING CAPITAL MANAGEMENT

Presiding: GERALD A. POGUE†

A Generalized Cash Flow Approach to Short-Term Financial Decisions

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I. The Need for a Generalized Approach

PAST NEGLECT of short-term financial management decisions. In the recent years, short-term finance—sometimes referred to from the accounting perspective as working capital management—has enjoyed much more attention than it has been accorded in the past. Part of the reason for past neglect could be attributed to the academic focus on market efficiency. Given perfectly efficient capital and product markets, there is very little room for short-term financial decisions to make any difference.[1] In the past several years, there seems to have been a surge of interest in short-term finance topics. Besides an increased academic interest in the subject as evidenced by the number of journal articles and the emergence of a new journal, *The Journal of Cash Management*, there has been increased interest by corporate managers, financial institutions, and monetary authorities.

Compartmentalization of short-term finance topics. Interest in short-term financial topics, however, has developed along fragmented lines. For example, there is a substantial literature on credit policy and associated accounts receivable management as well as a large collection of articles on inventory management, but few attempts have been made to integrate credit policy and inventory management decisions.

There are at least two reasons for this compartmentalization. First, each element of short-term finance is managed by an organizationally separate entity. Cash managers manage the cash, credit managers manage receivables, and payables managers manage payables. In most firms, these managers may be separated by several organizational layers. Hence, we have learned to think of short-term finance problems as separable decisions. Second, accounting conventions compartmentalize short-term assets and liabilities into packages. This has led some in the past to build decision models based not on sound financial

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[1] Lewellen, McConnell, and Scott (4) show that in a world of perfect financial and product markets there should be no trade credit.

principles but on these accounting constructs. For example, since there is a category of assets called "accounts receivable," it is tempting to view credit policy decisions from the impact such decisions would have on accounts receivable. This could yield erroneous decision criteria and could also isolate credit decisions from other changes in inventory and cash, for example.

There have been limited attempts to examine several of the working capital decisions in an integrated framework. Beranek [1] examined the interrelationship between inventory, order-quantities and the appropriate time to pay accounts payable. Schiff [11] and Schiff and Lieber [12] examined the joint consideration of the investment in inventory and accounts receivable. A linear programming model was used by Mehta [7] and a goal programming framework was used by Mehta [7], Mao [6], and Sartoris and Spruill [10] in an attempt to treat several of the elements of the working capital decisions simultaneously.

Need for a consistent valuation framework. In addition to the compartmentalized nature of much of the work in the working capital area, many of the approaches focus on accounting variables rather than cash flows. However, the approach taken towards accounts receivable policy by Kim and Atkins [3], Hill and Reiner [2], Lieber and Orgler [5], and Sartoris and Hill [8] casts the credit policy decision in the decision framework of maximizing the net present value of the firm. This article extends the net present value concept, incorporating the interactions between the various working capital elements.

II. Valuation Approach: The Cash Flow Time Line

Separability of Cash Stocks and Flows: Most short-term financial decisions fall into two categories: (1) those that directly affect the amount and/or timing of cash inflows and outflows, and (2) those that are concerned with the volume of cash or near-cash assets (liquidity). While these two categories are closely related to each other, it is helpful to view them as separable for decision purposes. The primary advantage for assuming separability is that financial theory provides well established tools for dealing with differences in the timing and amount of cash flows. The theory is less well established for determining the amount of liquidity needed.

The Cash Flow Time Line: Figure 1 shows the cash flow timeline. The clock starts (somewhat arbitrarily) when materials are purchased and there is a cash

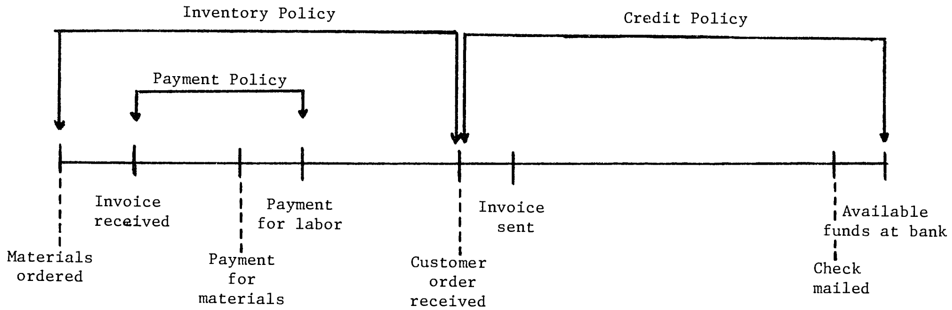

Figure 1. The Cash Flow Timeline

outflow. The time line extends through invoicing, credit and collection and ends when the firm receives available funds in its bank account. The model developed subsequently centers on changes that occur in the timeline as a result of managerial decisions. Note that the timeline crosses many organizational borders, such as: cash management, credit management, inventory management, and payables management. With this approach, rather than focusing on changes in accounts receivable, for example, the focus is shifted to changes in the amounts and timing of cash flows in the entire timeline.

Interrelationships between elements of the timeline: Short-term financial decisions are a mixture of separate and interrelated decisons. Some decisions will affect only the timng of one piece of the operating cash flows. For example, the policy decision to pay production workers once a month instead of bi-weekly will affect only the timing of the cash outflow associated with the production. Other decisons will affect the amount and/or timing of several sets of cash flows. For example, a decision to tighten credit by denying credit to slow paying customers would shorten the average time for sale to collection of accounts receivable but would likely reduce the total volume of sales and production. Consequently, the amount of cash flows for the purchase of materials and payments for the factors of production would be reduced, although the timing of these payments might not be altered. Thus, to assess the impact of a working capital policy decision on the value of the firm the interrelationship between the timing and the amount of the cash flows in the full time line would have to be considered. In the next section we present a model to illustrate this framework.

III. Cash Flow Framework under Certainty

The model developed in this section is similar, but more general, than the pioneering work of Lieber and Orgler [5]. For now we assume that the cash flows connected with any working capital policy decision are certain, both in timing and in amount, and can be discounted at the risk-free rate. We arbitrarily anchor our present value calculation at the time of the placement of the order for materials.[2]

We further assume that all costs of production are variable costs and can be expressed as a percentage of sales. Later in the paper we will drop this assumption. Relevant cash flows are the payment for factors of production (materials and labor), the collection of credit sales during a cash (or early payment) discount period, and the collection of the remainder of the credit sales.[3] The day is the basic unit of time over a planning/decision horizon of N days. We later examine the conditions under which the choice of the unit of time and the planning horizon are not crucial to the value maximizing decision.

[2] The choice of the zero point for the present value analysis is arbitrary. To convert from our chosen zero point to any other, such as the day on which the sale was made, would simply require multiplication or division by the appropriate discount factor.

[3] We could treat as separate cash flows the payment for materials and the payment for labor. We could also consider each sale to be collected on the day of the sale. We ignore these to keep the formulations simple without any loss of generality.

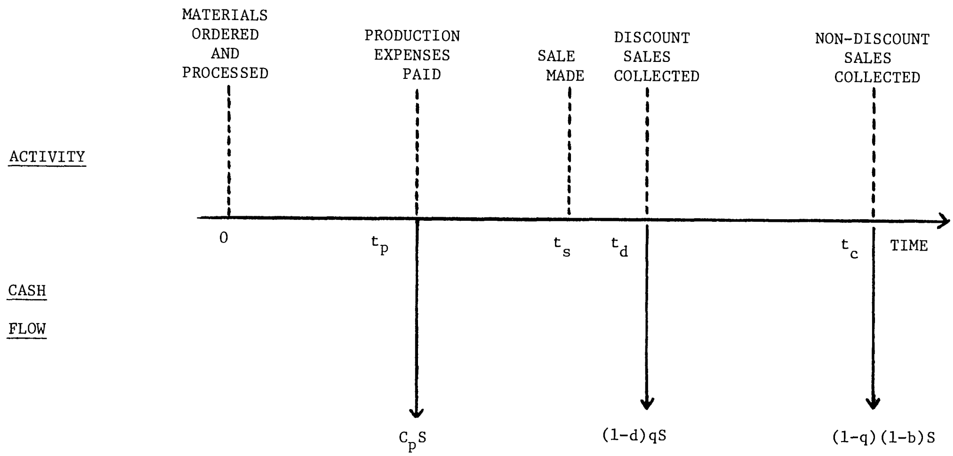

Figure 2. Operating Cash Flows

The cash flow for the payment for the factors of production is C_pS_t, where C_p is the variable costs expressed as a fraction of the sales of S_t. The cash flow occurs on day t_p. The firm collects $(1 - d)qS_t$ on day t_d from customers that take the cash discount, where d is the discount and q is the fraction of the sales paid with a discount. The final cash flow of $(1 - q)S_t(1 - b)$ is received on t_c where b represents the percentage of non-discount sales that are not collected, i.e. bad debts.[4] The timing of these cash flows is shown in Figure 2. If r is the risk free rate the net present value of the operating cash flow for the sales for day t is

$$NPV_t = -C_pS_te^{-rt_p} + (1 - d)qS_te^{-rt_d} + (1 - q)S_t(1 - b)e^{-rt_c}. \tag{1}$$

To simplify further calculations let us substitute new notation as follows:

$$PP \equiv C_pe^{-rt_p} \qquad (2)\ (a)$$

$$PD \equiv (1 - d)qe^{-rt_d} \qquad (b)$$

$$PC \equiv (1 - q)(1 - b)e^{-rt_c} \qquad (c)$$

We thus have for the NPV of day t's sales:

$$NPV_t = -PPS_t + PDS_t + PCS_t. \tag{1a}$$

Future sales are expected to grow along some growth path, $f(t)$, over time. We allow for any generalized growth pattern. We could represent constant growth at a rate g per period by $f(t) = e^{gt}$. We could allow for product life cycle growth by letting $f(t)$ be a polynomial. Seasonal growth could be represented by an exponential such as $f(t) = e^{g(t)t}$, where $g(t)$ is some function of time. Declining sales can be treated as negative growth. We allow the time pattern of sales to follow a

[4] Our treatment of bad debts can be shown to be equivalent to the treatment of Lieber and Orgler [5] where they examine the present value of the collections after the due date minus the cost of the collection effort. This equivalent will exist if our $b = [\lambda - g\lambda/(1 + r)^{-V}2]$ where λ, g, and V_2 are from these Equations (8) on page 215.

general functional form. Thus, the sales at any time are

$$S_t = S_0 f(t) \tag{3}$$

where S_0 is the amount of sales at $t = 0$ and $f(t)$ is the time pattern of sales. The only requirement on $f(t)$ is that it be a continuous function of t and that it be non-negative.[5] The total net present value of the sales over the entire planning horizons is

$$NPV = \int_0^N (-PP + PD + PC)S_0 f(t)e^{-rt}\, dt. \tag{4}$$

We now treat a general case of a change in working capital policies, where a "primed" variable indicates a difference in either the timing or the amount. Assume that the working capital change would change the sales to $S'_0 f'(t)$ per day and would change the amount and timing of the cash flows as follows:

$$PP' = C'_p e^{-rt'_p} \qquad (5)\ (a)$$

$$PD' = (1 - d')q'e^{rt'_d} \qquad (b)$$

$$PC' = (1 - q')(1 - b')e^{-rt'_c} \qquad (c)$$

$$NPV' = \int_0^N (-PP' + PD' + PC')S'_0 f'(t)e^{-rt}\, dt. \tag{6}$$

Our decision criterion becomes accept the alternative policy if

$$NPV' - NPV = (-PP + PD' + PC')S_0 \int_0^N f'(t)e^{-rt}\, dt$$

$$- (-PP + PD + PC)S_0 \int_0^N f(t)e^{-rt}\, dt \geq 0. \tag{7}$$

In general we must examine the sales growth which would occur over the indefinite planning horizon before we can establish whether the old or the proposed working capital policy will result in the higher NPV. To evaluate the change in general, we need to know both the planning horizon over which the policies are to be evaluated, and the time pattern of sales that will result from the alternative policies.

However, consider a special case. If $f(t)$, that is, the time pattern of sales, is not altered by the change in working capital policy, we can simplify (7) to

$$[(-PP' + PD' + PC')S'_0 - (-PP + PD + PC)S_0] \int_0^N f(t)e^{-rt}\, dt \geq 0. \tag{8}$$

Since we have assumed that $f(t)$ is non-negative over the planning horizon, and

[5] A negative value for $f(t)$ would imply negative sales. The only conceivable situation in which negative sales could occur would be if the returns over some time interval were larger than the sales during the period. We do not feel that this restriction causes any great loss of generality.

since e^{-rt} is a non-negative function for all real t and r we have that

$$\int_0^N f(t)e^{-rt}\,dt \geq 0. \tag{9}$$

We can divide both sides of the inequality in (8) by the integral without changing the direction. If we do this we have as our decision criterion accept if:

$$(-PP' + PD' + PC')S_0' - (-PP + PD + PC)S_0 \geq 0. \tag{10}$$

Under these conditions the planning horizon and the time patterns of sales growth are irrelevant. Any convenient sub-unit of time (we have chosen a day for convenience) can be used for the valuation. If the equation (7) were reformulated to use discrete rather than continuous compounding we would have a variant of the net present value decision criterion used for determining an appropriate cash discount policy by Hill and Reiner [2] and in looking at credit policy alternatives by Sartoris and Hill [8].

Comparison with Traditional Approach

It has recently been shown by Weston and Tuan [13] that the use of a binomial expansion of the net present value approach is approximately equal to the "traditional" or textbook approach to credit policy. While this is correct, the traditional approach, which is based on investment in receivables, directly can handle only a sequence of flows which meet the conditions to be treated as a reversible investment. The traditional approach can not easily be modified to incorporate uneven flows, such as a growth in sales or a seasonal pattern of sales, or fixed costs. Only with great difficulty and complexity can the traditional approach be expanded to incorporate the interaction of the credit policy decision with other elements of working capital, such as accounts payable or inventory, whereas, equation (7) can easily be expanded to treat directly *all* of the interactions that are likely to occur in working capital decisions.

When the Planning Horizon is Irrelevant

We now consider the question of what types of short-term financial decisions will cause an alteration in the time pattern (growth) of sales and what types of policy decisions will leave the time pattern unchanged. If the decision leaves the pattern unchanged, then (10) may be used as the decision criterion.

In addressing this question it is useful to make a distinction between market demand (total demand for a product) and market share (demand for a particular firm's product). Policy decisions which alter the market demand will likely change the time pattern of future sales, that is $f'(t) = f(t)$. For these types of policy changes it will be necessary to specify the planning horizon and to specify the time pattern of sales over that horizon. Thus we must use (7) as a decision criterion. Policy decisions which do not alter total market demand, but rather only affect market share, will result in $f'(t) = f(t)$. (At least after some short adjustment period.) That is, they may alter the distribution of total sales between competitors but they will not alter total product demand. The growth in demand for the product, the dimensions of the product life cycle, or the seasonality of sales will generally not be affected by policies which simply alter the position of one competitor vis à vis that of another competitor. Consequently, the problem can frequently be reduced to whether working capital policy decisions will affect market demand or market share. Clearly, decisions concerning accounts payable and accrued expense policies will have no effect on product demand and minimal effect on market share. Inventory policy decisions will have an impact either on the production costs or on the availability of the product on short notice. The former of these will affect the timing and perhaps the amount of the production costs but will not have an impact on market demand unless the change in production costs influences the product price and therefore the demand. The latter of these will have an effect on the willingness of customers to buy from a particular firm but, in general, not on the overall product demand.

Finally we are left with credit policy decisions where a firm offers credit to a group of potential customers to which no other competitors are currently selling on credit and where the group of customers could neither pay cash nor obtain the financing from any other source at a comparable cost. In this situation the credit policy decisons would affect the total market demand.

The vast majority of working capital decisions would only have an impact on market share and not on market demand. Hence, in most short-term financial decisions we can use the simplified decision criterion shown in (10) and need be concerned with neither the time pattern of sales nor the planning horizon.

Fixed costs. So far we have restricted the analysis to the consideration of changes in variable costs. We now consider how the decision criterion would have to be altered if the firm has some fixed costs (i.e. periodic costs) which will change because of a change in an element of working capital. The formulation for the present value of the current working capital policy will need to be modified to include fixed costs. Assume the firm incurs fixed costs in the amount F every τ days. (For simplicity assume these costs are paid on τth day.)

We can define these fixed costs, at time t, FC_t, as

$$FC_t = F\delta(t - \tau) \tag{11}$$

where

$$\delta(t - \tau) = \begin{cases} 1 & \text{if} \quad t = j\tau, \qquad j = 1, \qquad 2, \cdots N/\tau \\ 0 & \text{otherwise} \end{cases}$$

The total net present value will consist of the present value of the variable elements minus the present value of the fixed costs.

$$NPV = \int_0^N [(-PP + PD + PC)S_0 f(t) - F\delta(t - \tau)e^{-rt}]\, dt. \tag{12}$$

The firm now considers a change to a new policy. The decision criterion is to accept the new policy if

$$\int_0^N [(CM' - CM)f(t) - (F' - F)\delta(t - \tau)e^{-rt}\, dt > 0 \tag{13}$$

where

$$CM = (-PP + PD + PC)S_0.$$

In general when fixed costs change it is necessary to examine the working capital decision over the entire planning horizon of the firm. We now develop the sufficient conditions for which we can limit the analysis to the investigation of the net present value over one fixed cost cycle. If we have

$$\int_{j\tau}^{(j+1)\tau} f(t)e^{-r(t-j\tau)}\,dt \leq \int_{(j+1)\tau}^{(j+2)\tau} f(t)e^{-r[t-(j+1)\tau]}\,dt \tag{14}$$

and

$$\int_0^{\tau} (CM' - CM)f(t)e^{-rt}\,dt - (FC' - FC)e^{-r\tau} \geq 0 \tag{15}$$

then it is true that

$$\int_{j\tau}^{(j+1)\tau} (CM' - CM)f(t)e^{-rt(t-j\tau)} - (FC' - FC)e^{rt} \geq 0 \quad \text{for all} \quad j = 0, \ldots, N/\tau \tag{16}$$

The correct decision can be made by examining the present value of the cash flow only over one fixed cost cycle knowing we would make the same decision if we analyzed the entire planning period. Similarly the converse of the situation is true, if the direction of the inequalities are reversed the policy decision will be unaltered by the length of the decision horizon.

Interrelationship between cash flows and liquidity: As with any general decision framework, not all factors for any particular decision can be fully specified. We have assumed that liquidity considerations were separable from the evaluation of cash flows. This is not generally true. For example, a proposed lengthening of credit terms increases the amount of borrowing required. This may lead to higher interest rates and/or violation of credit line agreements. Hence, the decision process would not be a rote application of a present value model, but an iterative process that considers relevant liquidity constraints and costs. This is no different from the evaluation of a capital budgeting project where the investment and financing decisions are treated separately and the firm must arrange the necessary financing if it accepts the project.

IV. Modeling Uncertainty

In the previous section, we showed that treating one day's transactions is equivalent, in many cases, to treating a larger time span of transactions. We assume henceforth that conditions are such that we can use the simple problem formulation for comparing credit policy alternatives. In this section we also focus on only one segment of the timeline involving credit policy. The same principles could be extended to a broader segment, but this restriction will afford some simplicity.

Uncertainty Measures

While numerous measures are available to summarize the degree of uncertainty in cash flows, we use variance in this paper. First, it is an easily understood and simply derived measure. Second, other measures (such as covariance with a market index) would provide more severe estimation problems. Third, we show later that policies can be developed that result in zero variance. When variance is zero, most other measures of risk would also be "neutralized."

Sources of Uncertainty in Credit Policy Changes

When a firm changes credit policy, such as credit terms or classes of customers securing credit, there are several possible sources of uncertainty.

1. *Fraction of Sales Paid with a Discount.* Suppose, for example, that a firm moves from a policy of 2/10, net 30 to 3/10, net 30. We may know the timing of the payments but there may be uncertainty in the proportion of customers paying early with a discount under the proposed policy.

2. *Timing of Payments.* Changing credit terms could cause a shift in the pattern of payments. In the above example, "net 30" may mean the payment actually occurs on day 32 in our policy but day 40 or 41 under another policy.

3. *Volume of Sales.* Changing credit terms may influence the number of units sold. This would be the case in a liberalization of credit standards or in an increased cash discount (which is viewed as a de facto price decrease). The amount of increase would be uncertain.

4. *Bad Debt Losses.* Changing credit policy might also affect the fraction of sales that are never paid: bad debts. Under a new policy, this fraction would likely be uncertain.

Of course, any or all of the four could exist simultaneously further complicating the problem. The purpose of this section is not to exhaustively treat all forms of uncertainty. Rather, we want to illustrate the treatment of uncertainty in the cash flow approach developed previously.

Three Methods of Dealing with Uncertainty

Besides the possibility of ignoring uncertainty, the decision maker could handle uncertainty in three ways.

1. *Simulation.* Relying on initial estimates of the unknown parameters and estimates of how two or more of the parameters might interact, it is possible to simulate the results of credit policy changes. This approach was reported by Sartoris and Hill [9]. While this is a more complex approach, it may be the only way to handle interrelationships between various parameters. Sensitivity analysis may be performed to account for uncertainty in parameter estimation.

2. *Pricing Uncertainty.* Another approach is to price uncertainty borrowing a standard model such as capital asset pricing or arbitrage pricing. Then uncertainty in cash flows could be segmented into diversifiable and non-diversifiable components. Decisions would be based on maximizing risk-adjusted present values of cash flows. While this approach merits further consideration, we do not pursue it further in this paper.

3. *Risk Neutralization.* Another way to deal with uncertainty is to formulate

policies which neutralize risk. For example, if the uncertainty is associated with the timing of payments, a risk neutralizing policy would require that payments be adjusted over time so that the firm is indifferent to when the payment is made. As this approach has direct implications for credit policy decisions, we amplify it through two examples.

Example 1: Discount Fraction Uncertainty

Suppose the firm's current policy requires payment of S on day t_d and that this payment is certain. Now, we want to change policies and allow payment with a discount d on day t_d or payment in full t days later. We don't know what fraction, $\tilde{q}$, of sales will be paid on day t_d or what fraction, $(1 - q)$, will be paid t days later. Let R_t be the present value factor for day t so that $R_t \equiv 1/(1 + r)^t$, where r is the daily interest rate. Let D be the cash discount factor so that $D = (1 - d)$, where d is the cash discount fraction. Defining t_d to be day zero, the present value of cash flows (CF) is

$$\text{CF} = \tilde{q}DS + (1 - \tilde{q})R_tS, \tag{17}$$

where s is the dollar sales. The variance caused by the uncertainty in $\tilde{q}$ is computed as

$$\text{Var(CF)} = (DS - R_tS)^2\sigma_q^2. \tag{18}$$

Note that the variance can be neutralized, or made to equal zero, if $DS - R_tS = 0$. This happens when $D = R_t$, or when

$$(1 - d) = \frac{1}{(1 + r)^t}. \tag{19}$$

In other words, the firm is indifferent to receiving a dollar now discounted by a cash amount and a dollar in the future discounted by an equivalent present value factor. Both dollars are exactly equivalent and the riskiness of the cash flow caused by the uncertain q has been neutralized.

Example 2: Timing Uncertainty

Timing uncertainty means that under a set of credit terms we may not know when a payment will be made. For simplicity, assume there are two possible payment dates t_1 and t_2. An uncertain fraction, $\tilde{q}$, of sales will be paid on day t_1 while the remainder $(1 - \tilde{q})$ will be paid on day t_2. Let R_1 and R_2 be present value factors corresponding to t_1 and t_2. The present value of cash flows from S sales dollars under this policy will be

$$CF = \tilde{q}R_1S + (1 - \tilde{q})R_2S \tag{20}$$

The variance of the present value of cash flow is then

$$\text{Var}(CF) = (R_1S - R_2S)^2\sigma_q^2 \tag{21}$$

To make the policy risk neutral, we set this variance equal to zero or

$$R_1S = R_2S. \tag{22}$$

But, this can never happen since $R_2 < R_1$ for all positive interest rates. Hence, we cannot have a risk neutral policy unless we impose a penalty for payments made on t_2. The penalty factor, K_2, would have to be such that

$$R_1 S = R_1 S K_2, \quad \text{or}$$

$$R_1/R_2 = K_2, \tag{23}$$

where $K_2 = 1 + k$ and k is the fraction of sales added on for every dollar of sales paid on t_2. This idea leads to a rational penalty policy that says (barring default risk) the customer may pay whenever convenient (perhaps within limits) provided that when the payment is made, the price paid is adjusted by the penalty factor $K_n = R_1/R_n$.[6]

VI. Conclusion

Because firms have historically segmented working capital decisions into widely separated organizational structures, the traditional approach to working capital problems has likewise been compartmentalized. We argue that an integrated approach can be more fruitful. The integration comes in realizing that most working capital decisions involve either the cash flow cycle or the level of liquidity. While the two are closely linked they can be separated to some extent for decision purposes. This paper focuses on the cash flow cycle part of working capital. This focus allows us to view policy decisions as they impact the timing and amount of cash flows which, in turn, are amenable to standard present value analysis.

The paper develops first a certainty model for working capital decisions. The model is shown to be robust with respect to various sales patterns and cost assumptions. Uncertainty is then introduced and three methods are suggested for dealing with it: simulation, explicit pricing, and neutralization. The latter method was illustrated for credit policy decisions and "rational" credit policies were discussed.

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[6] In practice, some firms do have an adjustable payment schedule such that payments made after 30 days have a 1% penalty fee, payments made after 60 days have an additional 1% fee, etc.

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