WORKING CAPITAL MANAGEMENT FOR THE MULTINATIONAL FIRM: A SIMULATION MODEL

Andre Fourcans[1] and Thomas J. Hindelang[2]

[1] ESSEC, Paris, France

[2] Drexel University

ABSTRACT

The rapid growth of multinational corporations has hastened the need for the development of powerful models to reflect the new complexities imposed by the international interface. Working capital management is complex in the uninational setting where the firm must weigh the trade-offs between the liquidity and profitability of its current assets in the face of uncertainty. Significant additional dimensionality is added to the problem when foreign exchange rates, foreign tax methodologies, new sources of funds from foreign money markets, and new multi-faceted social, economic, and political factors are superimposed on the framework. This paper develops a simulation model to assist the multinational firm in the management of working capital for all of its subsidiaries considering their needs, world-wide short-term opportunities, and global sources of short-term funds. The simulation methodology is used in conjunction with a linear programming model which determines the optimal sources and uses of short-term funds for each subsidiary given the values that have been generated for each exogenous variable in the system. The overall model capitalizes on the strengths of both simulation and the linear programming optimization model and thus, yields a flexible but robust approach to this difficult problem setting.

I. INTRODUCTION

Working capital management is complex and challenging even in the uninational setting. Such is the case because of the necessity for the firm to cope with difficult, numerous, and interrelated decisions. The international interface imposes still greater dimensionality on the problem. The imbedded uncertainty requires a stochastic treatment.

This paper formulates a simulation based linear programming model to assist the multinational firm in the management of its worldwide working capital decisions: subsidiary policies, needs, and transfers; opportunities in money markets throughout the world; and the acquisition of short-term funds. The model's endogenous variables are allowed to vary according to their probability distributions. Then, the linear programming model is solved based upon the values generated. Through this approach, empirical distributions are derived to assist management in the decision making process. The model developed is robust yet flexible in that it capitalizes on the strengths of both simulation (the reflection of stochastic elements in the environment) and linear programming (the ability to determine an optimal solution to the problem given the generated values of the input variables).

The next section of the paper will discuss the problem and issues involved as well as briefly reviewing the literature in the area. Section III will develop the model. Finally, analysis of the model's output and conclusions will be presented in section IV.

II. STATEMENT OF THE PROBLEM AND REVIEW OF THE LITERATURE

From the multinational corporation's point of view, the literature in working capital management has been limited by one or more of the following three shortcomings:

1. Consideration of each decision subsystem of the

working capital total system as if it functioned in a vacuum;

2. Failure to adequately reflect the important international dimensions of the working capital problem;

3. Making the simplifying assumption that all of the model's parameters are known with certainty.

Without question, the analysis of the major components of the working capital total system has evolved to a somewhat advanced state. In the area of cash and marketable securities, Baumol (1), in a pioneering work, analyzed the transactions demand for cash using an inventory theoretic approach. This work has been extended by numerous authors whose models enrich the basic approach to the management of these two related areas. Miller and Orr (13), by introducing additional stochastic variables into the analysis, approach more closely the real world conditions faced by firms. Robichek, Teichroew, and Jones (16), Eppen and Fama (6), Calman (3), and Orgler (15) all reflect the relevant dynamic or intertemporal effects of cash and marketable securities planning by formulating multiperiod linear programming models. Among these, Orgler's model is the most sophisticated. His incorporation of more relevant decision variables and greater flexibility through the unequal time-period aspect significantly enhance the model's realism. Most recently, the development by Sethi and Thompson (20) of a cash management model based on optimal dynamic control theory could be the springboard of a very promising approach.

In the area of accounts receivable and credit policy management, Benishay (2) utilizes statistical quality control to help ascertain when difficulties arise with a given credit policy. An aid in accounts receivable management through the use of Markov Chaines is provided by Cyert, Davidson, and Thompson (5). Dynamic programming has also been applied to the receivable credit policy question by Mehta (11). Finally, inventory theory and practice has developed to an advanced state as evidenced by the abundant literature in the area of which the classic work by Hadley and Whitin (8) is representative.

However, all of these developments suffer from the significant weaknesses mentioned at the beginning of this section. Their predominant shortcomings reside in their analysis of each component of working capital as if it were a decision system functioning independently of the other working capital elements. These types of approaches, by advocating such specialization and allowing for little or no coordination and integration of the closely related working capital decision-subsystems, expose firms using them to considerable suboptimization.

Only two major contributions have tried to reflect multinational variables in their analysis of working capital elements. Rutenberg (17), by formulating a generalized network model (similar to an LP model), enables the multinational firm to maneuver liquid assets via an optimal use of tax havens. A sophisticated parametric quadratic programming model has been developed by Lietaer (10). Its purpose is to optimize the trade off between the expected costs and risks associated with foreign exchange rate fluctuations. Both of these models partially overcome the second major shortcoming mentioned earlier, but, unfortunately, still suffer from the first by only considering a small part of the total working capital system.

Recently, Merville and Tavis (12) developed a total systems approach in dealing with the working capital management problem. The authors formulate a chance-constrained E-model which reflects the interrelationships among cash/marketable securities planning, credit policy selection, inventory policy determination, and the short-term funds acquisition. However, this model is constructed only for domestic operations.

Fourcans, Hindelang, and Merville (7) formulated a mixed-integer, linear programming model to maximize the multiperiod return on near cash investments for the multinational firm. However, conditions of certainty were assumed.

The model proposed in this research is based on the approach taken in (7) and extends the model developed by the authors to the "risk" area via simulation. Thus,

the current model overcomes all three of the major limitations cited at the beginning of this section by capitalizing on the total systems approach to working capital management, by reflecting the critical international variables, and by incorporating stochastic variation into the analysis. The model promotes effective management of working capital for the multinational firm by maximizing return on investments, facilitating the financing of subsidiaries, optimizing the movements of royalties and fees and limiting exposure to international risks.

III. THE NEW MODEL

As mentioned above, the task of managing working capital in toto is indeed complex for the multinational firm. Operations must be financed in multiple and diverse settings, world-wide short term investment opportunities must be scanned, and sources of funds both internal and external to the firm must be evaluated in order to arrive at an optimal allocation. Thus, an optimization model (such as linear programming--LP) will provide valuable assistance to the international firm in handling the major decisions. However, the fact that so many of the relevant variables are imbedded with uncertainty makes simulation a natural complement to the optimization model. Hence, the proposed approach will be to solve an LP problem at each simulation trial based on the generated values of the input variables. At each trial the values for all decision variables will be obtained as will the value of the objective function. At the end of the simulation, an empirical distribution of the value of the objective function will be available. Corresponding to each point in this distribution will be the values of the decision parameters which produced the observed results. Based on these outputs management can evaluate whether "steady state" conditions have been achieved and make their final decisions about the total working capital system. The approach here is similar to that of Salazar and Sen (19) and Cohen and Elton (4) in the capital budgeting area.

The optimization model which is utilized in the simulation is one developed by the authors in (7) to aid the multinational firm in managing its working capital operations. Rather than discuss this linear programming formulation in detail here, its main aspects will be summarized. The model and variable definitions are given in reference (7) which can be obtained from the authors.

The model is designed using the framework of a "centralized pool" to coordinate world operations and to capitalize on system interrelationships plus the various subsidiaries located throughout the world. The pool would scan the world environment in order to select optimal investment opportunities and sources of short-term funds (either from money markets or intersubsidiary loans). Each subsidiary is able to finance its current operations and to invest other funds up to a negotiated amount. Beyond this the pool assumes control and directs the activities of each subsidiary, excess funds obtained from various subsidiaries are invested by the pool either in the world market or lent to other subsidiaries. Foreign taxation, foreign exchange rates, currency controls, and economic, social, and political factors in the various host countries are the main elements the pool must analyze to optimize the system's operation. Figure 1 summarizes the sources and uses of funds for subsidiaries and the centralized pool.

Constraints in the model separate working capital into temporary, permanent, and incremental components. Quantitative controls and management policies dictate that upper limits be expressed on borrowings, royalties and fees, and transfers of funds between companies.

The simulation proceeds as shown in the flowchart given in Figure 2. Table 1 defines the parameters, exogenous, and endogenous variables. Of course, the input requirements are somewhat demanding but it is felt that the corporate staff plus the local experts at each subsidiary should be able to provide rather accurate probability estimates.

The model's output and its analysis are now discussed.

IV. ANALYSIS OF OUTPUT AND CONCLUSIONS

As mentioned briefly above, the output from the simulation is an empirical distribution for the value of the objective function of the LP model plus the optimal values of all decision variables for each simulation run based on the generated input values. Of course, since the objective function is being maximized, the upper

FIGURE 1

CASH FLOWS FOR
EACH SUBSIDIARY

USES	SOURCES
1. Operations and Inventory	1. Operations
2. Temporary External Debt and Subsidiary Loan Repayments	2. Credit Policy
3. Temporary Debt Service Loans from Pool	3. External Borrowing
4. Excess Funds - Pool	4. Intersubsidiary Loans
5. Excess Funds - W_j^s	5. Return on W_j^s
6. Royalties and Fees	6. Royalties and Fees
7. Incremental Financing Service	7. Borrowings from Pool
8. Loans made to other Subsidiaries	8. Repayments of Loans made by other Subsidiaries

CASH FLOWS FOR
CENTRALIZED POOL
OF FUNDS

USES	SOURCES
1. New Loans to Subsidiaries	1. New Excess Funds Transferred
2. New External Investment Opportunities	2. Principal and Interest on Old Funds

tail of the empirical distribution would be of greatest interest to the firm in terms of the values of the decision variables (most importantly, the short term investments which should be undertaken and the sources of working capital funds which should be utilized) which are implied. As the total working capital system approaches a steady-state behavior, the values of the decision variables corresponding to the upper tail of the empirical distribution will provide valuable information to the central pool concerning investment and financing activities.

As in ordinary LP, sensitivity analysis can be performed to determine the most critical input variables. Based on this information, a more careful analysis can be made of the probability distributions attributed to these critical variables.

It should be mentioned that even though the credit and inventory policies for each subsidiary are assumed to be parameters of the simulation model (because it is felt that these policies are more readily determined than are the values of the other decision variables in

FIGURE 2

FLOWCHART FOR THE SIMULATION

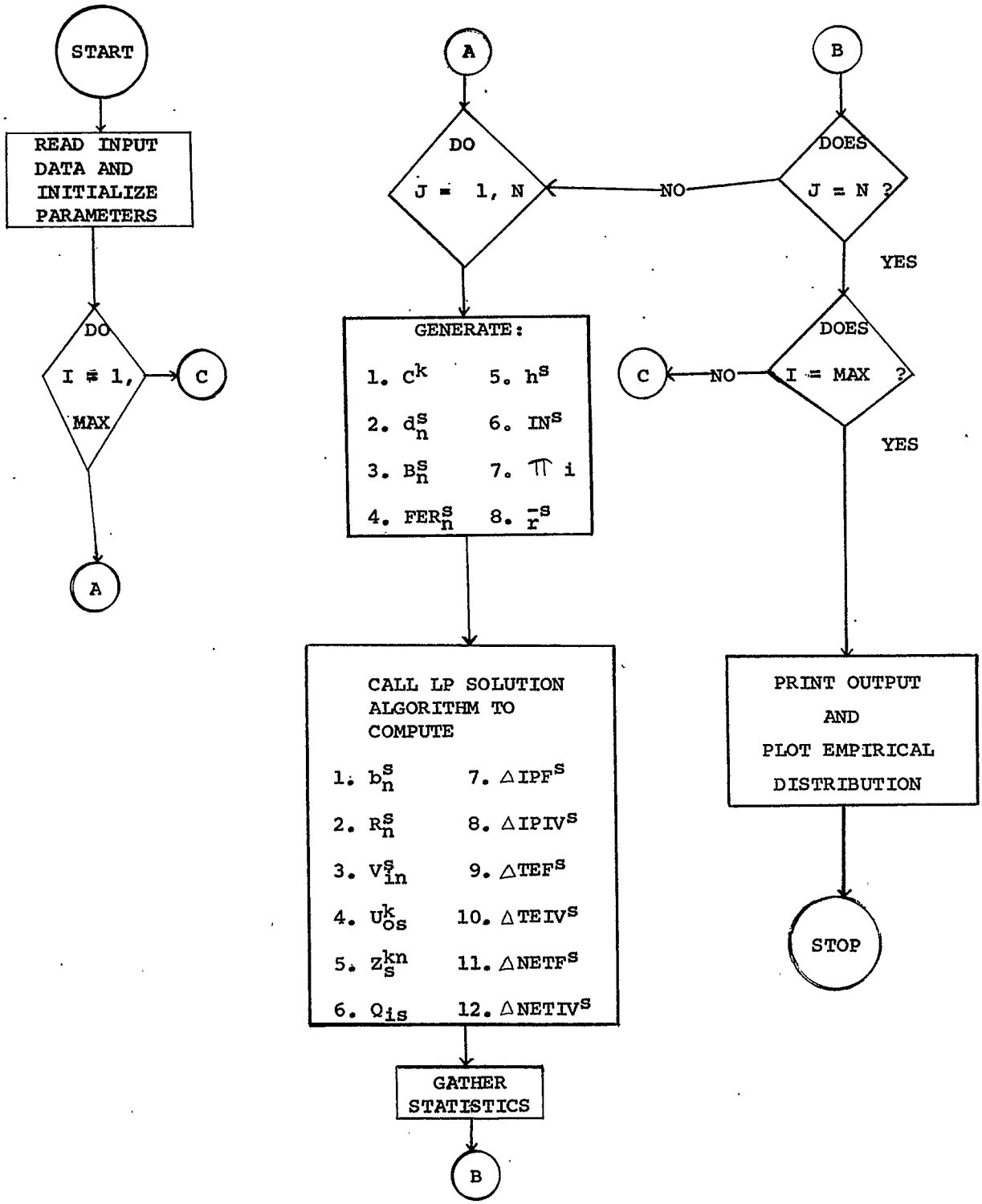

TABLE 1

VARIABLES OF THE SIMULATION MODEL

PARAMETERS

F_o IV_o = Minimum operational level of permanent working capital

DCE_o DCV_o = Minimum discretionary level of permanent working capital

H_j = Total cash outflows associated with non-working capital items--capital expenditures, dividends and long term financing requirements

X^s = Credit policy for each subsidiary s

Y^s = Inventory policy for each subsidiary s

P^s = Maximum proportion of "exposed" cash and receivables for subsidiary s

P'^s = Maximum proportion of "exposed" inventory for subsidiary s

L^{*n}_j = Maximum amount of intersubsidiary loans that can be made by subsidiary n in period j

LL^*j = Maximum amount of loans that can be made by the pool in period j

R^{*s}_j = Maximum royalties and fees which can flow out of country s in period j

V^{*s}_j = Maximum amount of excess funds which can be transferred out of country s in period j

Z^{*s}_j = Maximum amount of funds available from the money markets of country s in period j

MAX = Total Number of simulation runs to be considered

EXOGENOUS VARIABLES

Stochastic variables with known probability distributions:

C^k_j = After host country tax percent cost of borrowing funds from source k in period j

D^s_{jn} = Cash inflows from country s to country n in period j

B^s_{jn} = One minus the tax impact on funds shifted from country s to country n during period j

FER^s_{jn} = The foreign exchange rate in period j for funds flowing from country s to country n

h^s_j = The cash outflows required in period j associated with the credit and inventory policies selected for subsidiary s

IN^s_j = The total cash inflow from operations (other than revenue generated by the credit policy) in country s during period j

π_{ji} = After host country tax percent return on funds invested in alternative i during period j

$\bar{r}^s_j$ = After host country tax percent return on funds invested by subsidiary s during period j

ENDOGENOUS VARIABLES:

b^s_{jn} = The funds transferred from subsidiary s to subsidiary n in period j

R^s_{jn} = The royalties and fees paid by subsidiary s to subsidiary n in period j

V^s_{jin} = The excess funds available in country s in period j to be invested in alternative i in country n

U^k_{ogs} = The funds for incremental needs for subsidiary s obtained from source k

Z^{kn}_{js} = The funds for temporary needs for country s in period j obtained from source K in country n

Q_{jis} = The funds from the pool's resources to be invested in alternative i during period j in country s

$\Delta IPF^s + \Delta IPIV^s$ = The change in incremental permanent working capital for country s

$\Delta TEF^s_j + \Delta TEIV^s_j$ = The change in exposed working capital in country s during period j

$\Delta NETF^s_j + \Delta NETIV^s_j$ = The change in non-exposed working capital in country s during period j

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the model) it is possible to experiment with various combinations of policies for different subsidiaries. Those policies which lead to most desirable empirical distribution of the objective function for the model would be recommended by the centralized pool for the subsidiary in question.

The proposed simulation model should provide significant assistance to multinational firms in their complex task of management of the total working capital system. All components of the system have been represented in the model. The use of both simulation methodology and an optimization technique yields a robust yet flexible approach to coping with the very challenging aspects of the overall problem area.

The proposed formulation has not been validated to date. However, as with other such descriptive simulation models, validation can only be achieved as multinational firms become informed about the approach and implement it in practice. Thereupon revisions and refinements can be made to enhance the model's effectiveness. Further, as managers and the corporate staff become experienced in the use of the model, their skills in probability estimation, analysis of output, and sensitivity analysis will be developed more fully, thereby increasing the utility of the recommended treatment of the multinational working capital problem.

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