

MANAGING COMPANY CASH

by 45

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A MASTER'S REPORT

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requirements for the degree

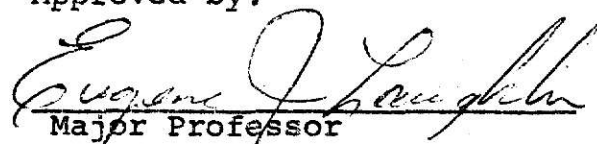
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TABLE OF CONTENTS

CHAPTER	PAGE
I. CASH MANAGEMENT IN PERSPECTIVE	1
Objectives	1
Components of the Cash Management Problem	4
The Cash Management Model	6
II. THE INFLUENCE OF INVENTORIES ON CASH MANAGEMENT	8
The Nature of Inventories	8
Predicting the Inventory to Sales Relationships	11
III. THE INFLUENCE OF ACCOUNTS RECEIVABLE ON CASH MANAGEMENT	24
The Nature of Receivables	24
Predicting the Receivables to Sales Relationships ..	25
IV. CONSTRAINTS ON THE CASH POSITION OF THE FIRM	31
Credit Constraints	31
Compensating Balance Constraints	33
The Liquidity Constraint	37
The Clean-Up Constraint	40
V. EXCESS CASH, INSUFFICIENT CASH AND SHORT-TERM INVESTMENT POLICY	43
Insufficient Cash	43
Excess Cash and Short-Term Investment Policy	44

CHAPTER	PAGE
VI. THE INTEGRATED CASH MANAGEMENT DECISION	48
Summary	48
The Final Model	50
Conclusions	57
BIBLIOGRAPHY	59
APPENDIX	61

LIST OF DIAGRAMS

DIAGRAM	PAGE
I. Cash Levels and Needs	9
II. The Regression of Inventories on Sales	14
III. Probability Distribution	18
IV. Superimposed Distribution of Diagram III (Yearly Basis)	19
V. Superimposed Distribution (Monthly Basis)	21
VI. Regression of Receivables on Sales	26
VII. Superimposed Distribution of Receivables and Sales Relationships	28
VIII. Liquidity Preference	39
IX. The Decision Tree	51

LIST OF TABLES

TABLE	PAGE
I. Historical Inventory and Sales Data	13
II. Explicit Costs of Credit	32
III. The Compensating Balance and the Liquidity Preference Constraint	36
IV. Relative Yield, Safety, Liquidity and Maturity of Short-Term Securities	45
V. Decision Tree Components	53

CASH MANAGEMENT IN PERSPECTIVE

CHAPTER I

Objectives

The objectives of this report are threefold. The first objective is to put cash management into its proper perspective within the general management framework of the firm. The second objective is to point out and examine the components of the cash management problem. The final objective is to develop an integrated model of cash management that considers all the components of the cash management problem in a logical form.

Current texts and studies in finance usually put cash management into a different perspective than will be used in this report. Most of these texts and studies state two objectives for the firm, liquidity and profitability. The following quotation establishes the position of cash management now accepted by most authors in finance.

The first objective of the financial manager is to see to it that bills are paid when due. Policy changes in production, marketing, and other areas of management almost always have some impact upon cash inflows and outflows. The second objective of the financial manager is to make a high rate of return on the investment of the proprietor, partners, or common stockholders. In this endeavor, he first tries to put his cash funds to work by investing them in various assets. To secure a high earning power on these operating assets, he dares not go too far in putting his cash to work, or he

will not be able to pay his bills.¹

This viewpoint is misleading in that it indicates dual objectives for the financial manager. Even though the behaviorial theory of the firm recognizes multiple objectives, the traditional economic theory assumes the single objective of profit maximization.² In this latter context liquidity is not an objective but instead a constraint upon profitability. This may appear at first to be just a matter of semantics; however, there are relevant implications of this approach to the cash management problem.

At this point it is necessary to clarify the objective of profit maximization. Profit maximization can be defined as the selection of those assets, projects and decisions which insure the use of the optimum volume and combination of resources in order to maximize the creation of economic value by an enterprise.³ This objective suffers from five major flaws. This concept is ambiguous as to whether it measures short-term or long-term profits. It does not specify clearly whether profits should be measured as a rate of return or an amount of return. It does not

¹Robert W. Johnson, Financial Management (Boston: Allyn and Bacon Inc., 1966), p. 61.

²James G. March, "Business Decision Making," Readings in Managerial Psychology, (Chicago: University of Chicago Press, 1967), p. 451.

³Ezra Solomon, The Theory of Financial Management (New York: Columbia University Press, 1967), p. 18.

define whose profits should be maximized. This concept does not deal with the timing of profits within the appropriate time period. Finally, profit maximization does not differentiate according to the quality of the earnings.

The concept of wealth maximization actually provides a more comprehensive statement of the economic objective for the total firm in that it recognizes not only the quantity but also the quality and timing of cash flows and it associates these flows with maximization of the owner's wealth.

The scope of this report is limited to problems associated with management of the firm's cash position in the short-run. The analysis of these problems will deal primarily with maximizing the level of profits earned by a firm with a given capital investment. This analysis will be for the short-run with a given capital investment and profits defined in terms of levels to avoid some of the problems pointed out on the previous page associated with profit maximization. The question in the wealth maximization model relating to the optimal capital investment will not be considered. The profit maximization goal for cash management will be accepted as a suboptimal goal within the broader wealth maximization concept. This suboptimal goal will be evaluated in terms of the factors directly related to establishing a "critical minimum" cash balance to be maintained by a firm. The "critical

minimum" will be defined later.

The firm should consider cash management in its relationship to the profitability objective and not in relation to an independent liquidity objective. Liquidity, like expenses and revenues, is required if the firm is to make profits. It can only be properly considered as another factor that is necessary for the firm to reach its ultimate goal. Beranek in his text states the problem as follows:

The conflict which confronts the suboptimizing treasurer is the fact that excess cash on hand is foregoing returns which could be obtained from a suitable alternative use, while inadequate cash spells the occurrence of a "short" cost. Somehow, he must reconcile the desire for returns with the desire to avoid "short" costs in a way which maximizes the attainment of his goals.⁴

Beranek makes it clear in this statement that the objective of the financial manager is profit maximization.

Components of the Cash Management Problem

The second objective of this report, to set forth and examine the components of the cash management problem, will deal with four such components. These components consist of inventory levels and flows, receivables levels and flows, constraints upon the investment in cash balances

⁴William Beranek, Analysis for Financial Decisions (Homewood, Illinois: Richard Irwin, Inc., 1963), p. 345.

and the problem of financing cash deficits or investing excess cash balances.

The second chapter will deal with the problems of predicting inventory levels and flows with attention given to the influence of seasonal variations and major economic changes. Statistical techniques will be used to derive predictions for future inventory levels and flows. These predictions will take the form of multiple estimates of outcomes rather than single point estimates. These same statistical procedures will be used in Chapter III to predict the levels and flows of receivables. It is necessary to be able to predict with a defined degree of accuracy the probability distribution of the possible outcomes for the levels and flows of receivables. These receivables predictions will be used in conjunction with the inventory prediction in evaluating cash management policy.

Chapter IV will consider certain constraints on the firm's cash position which also play an important part when making predictions of future cash needs. The bank balance required for the firm is such a constraint. The firm's bank may require compensating balances or place other restrictive measures on the firm's cash position. Other creditors extend financing for various lengths of time to serve the firm and may also put constraints on cash management. For example, they may impose strict credit standards on the firm for excessive use of credit in financing its profit making activities.

A further constraint on cash levels and flows will be the liquidity preferences of the managers of the firm. The liquidity preference of the managers as individuals may conflict with the liquidity requirements of the firm as an entity. This type of interaction may have strong implications for cash management. If individual managers require more personal liquidity than is in the best interest of the firm as an entity, then the owners may suffer in the long run.

Finally a firm must deal with the problem of predicting when it will have excess or insufficient cash. This introduces two additional problems for the financial manager. When the firm has excess cash the financial manager is faced with selecting among alternatives for short-term investments. If the firm has insufficient cash to meet its needs the financial manager is faced with the problem of where to seek funds. Both of these problems will be given further consideration in Chapter V.

The Cash Management Model

In laying out the problem areas associated with cash management, it is necessary to consider the cost of being short of cash. Thus, it is convenient to use the term "short cost" to designate any costs incurred as a result of having insufficient cash to meet the firm's liquidity needs. This "short cost" will be related to the previously

stated problems of cash management. There will be "short costs" associated with extending the payment of liabilities too long or for falling below the compensating balance requirement of the bank. Allowing credit policies which generate excessive investments in receivables will also cause the occurrence of "short costs". There are also "short costs" associated with foregone opportunities of a random nature that could have been taken had the firm had adequate cash balances or flows.

The minimum cash balance required to optimize "short costs", given the cash flows, will be referred to as the "critical minimum". The objective of the cash management model will be to determine this critical minimum within the context of the profit maximization concept.

This leads to the final objective of this report, the development of an integrated model that considers all of these areas of importance in a logical form. To do this, various statistical techniques will be adopted to avoid the use of one estimate for each solution to a problem. This final chapter, will set forth a dynamic model for systematic cash management decisions. All specific solutions to cash management problems will be tied to the determination of the "critical minimum".

CHAPTER II

THE INFLUENCE OF INVENTORIES ON CASH MANAGEMENT

The Nature of Inventories

Inventory investment has two impacts on cash management. First, cash balances are maintained to offset the difference in timing between cash inflows and outflows. The slower the inventory turnover the greater will be this timing difference and, hence, the greater the required cash cushion.⁵ Secondly, seasonal accumulations in inventory must be financed either internally through the accumulation of cash balances or externally through short-term borrowing. To the extent the financing is internal, the firm may hold cash balances in anticipation of future inventory investment. This will be considered in detail in Chapter V.

Firms subject to seasonal variations in their sales will experience periods of inventory accumulation followed by periods of rapid inventory liquidation. These firms must either adjust their inventory acquisition procedures to coincide more closely with their sales pattern or compensate for the fluctuations in inventory investment with adjustments in their cash management, receivables management and borrowing

⁵ Robert W. Johnson, Financial Management (Boston: Allyn and Bacon Inc., 1966), p. 240.

policies. The precise nature of such an adjustment will be determined by the cost of maintaining the liquidity required to support these working capital investments compared with the return earned on the investments.

The problem arises because the seasonal pattern of cash inflows from sales and the subsequent collection of receivables normally will not coincide with the seasonal pattern of cash outflows for either the purchases of inventory and the subsequent payment of accounts payable or the other cash needs of the firm.

The relation of cash needs in the firm and the level of cash available for use may in fact look like the following:

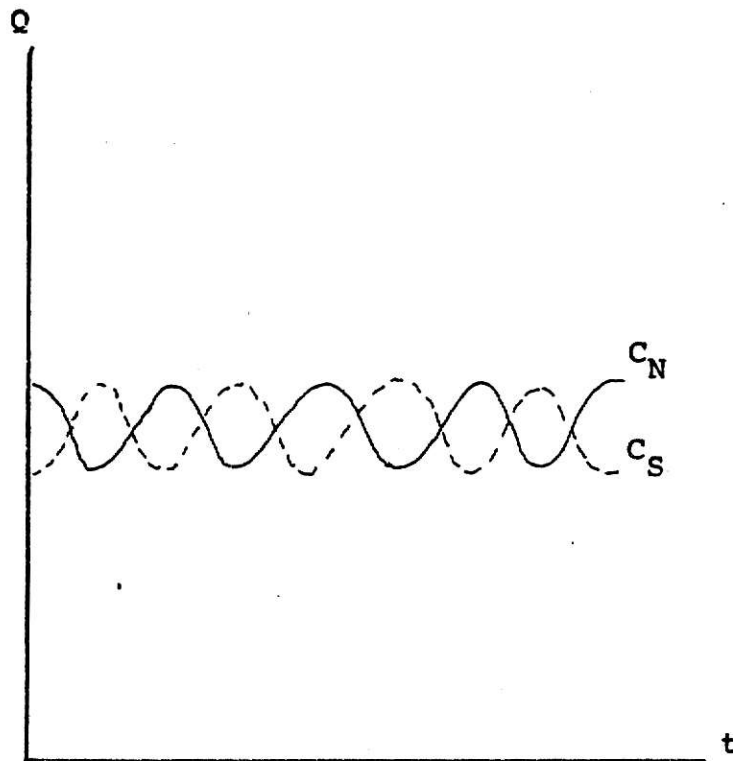


DIAGRAM I

CASH LEVELS AND NEEDS

where C_N = cash needs of the firm

C_S = the cash available to the firm

Q = quantity of cash

t = time

This is an extreme example of cash needs being the greatest just when the cash available is at its minimum. The relationship of cash needs to cash available may take the above form or various other forms depending on the relationship of cash levels and inflows to the outflows of cash. Since cash needs usually depend heavily upon inventory investment, it is apparent that inventory management plays a large part in cash management. Furthermore, production or purchasing policies are clearly tied to sales. Thus variation in sales due to seasonal or short-run cyclical variations may have a great impact on cash management.

Inventory flows are usually measured in terms of inventory turnover. This turnover is conventionally obtained by dividing cost of goods sold by the average inventory. For cash management purposes the time period for evaluating the inventory turnover may be based upon a cost of goods sold for a month and the related inventory investment. This period of measurement may be even shorter if necessary for cash management decisions. The firm will wish to know both the yearly turnover to aid in longer range cash management, and the monthly turnover to aid in current cash management.

Predicting the Inventory to Sales Relationships

Before an example is considered to illustrate the above, there is an additional factor that must be considered. This factor is the influence of major economic changes on inventory levels. Major economic changes such as war or police action may severely influence inventory policy. Conversely, withdrawal from a major war or police action may directly influence inventory levels and turnover. Any specific economic change may influence some particular firm's or industry's inventory levels and flows while leaving others unaffected. Some firms may be affected by a housing boom or slump, others by government credit policy and so on. There are a host of economic factors that will have varying influences on the inventory levels and turnovers of the firm.

Major economic trends, their influence and their duration must also be considered as part of this problem. If past trends in economic activity and in the working capital investment policies of firms lead to a reasonable expectation of an increase in the level or turnover of the inventory investment, cash managers must take this into account in making decisions. For example, the United States has been in an era of prosperity for most of its industries for three decades. If it is reasonable to expect that this trend will be continued, then cash management should be planned accordingly.

Thus, a firm needs to know the annual turnover and level of its inventories for a series of years. From this data the firm may be able to establish an increasing or decreasing trend in the levels and flows of inventory. Further analysis is needed to know whether a change in the trend of levels and flows of inventory will lead to a financing problem or a cash management problem.

The firm must break the yearly trend line down into predictions for each month. This must be done whether the trend line is expected to shift or not. The breakdown is necessary to determine whether the predicted values on an annualized trend line are influenced by temporary adjustments in inventory investments or by adjustments of a more permanent nature. For example, if the yearly trend line shifts three units to the left (See diagram II, page 14), the firm must then inspect the prediction lines for each month. If all the monthly trend lines shift somewhat to the left then it becomes clear that a general change in inventory policy caused the yearly trend line to shift. Thus, this is a financing problem not a cash management problem. However, if shifts in the monthly trend lines for only two months primarily accounted for the change in the yearly prediction line, it clearly becomes a cash management problem.

Since the cost of goods sold are directly related to sales it seems that it is appropriate to find the relationship between inventory level and sales. This may be done by stating both sales and inventories in terms of current retail prices. This will eliminate the problem associated with the different price bases for inventories and sales.

The firm may now take the past relationship of sales to inventories on a yearly basis and use regression analysis to determine the relationship between the two. The firm must modify the regression line with probability estimates about the future relationship of inventories to sales to make the prediction more accurate. Assume that the following data are available for a firm:

TABLE I
HISTORICAL INVENTORY AND SALES DATA

Years	1959	1960	1961	1962	1963
Sales	100	110	120	135	140
Inventories	50	50	65	70	75
Years	1964	1965	1966	1967	1968
Sales	150	165	175	195	200
Inventories	75	80	90	95	100

This relationship is illustrated graphically in Diagram II. It should be noted that the vertical scale, sales, is collapsed below sales of one hundred units.

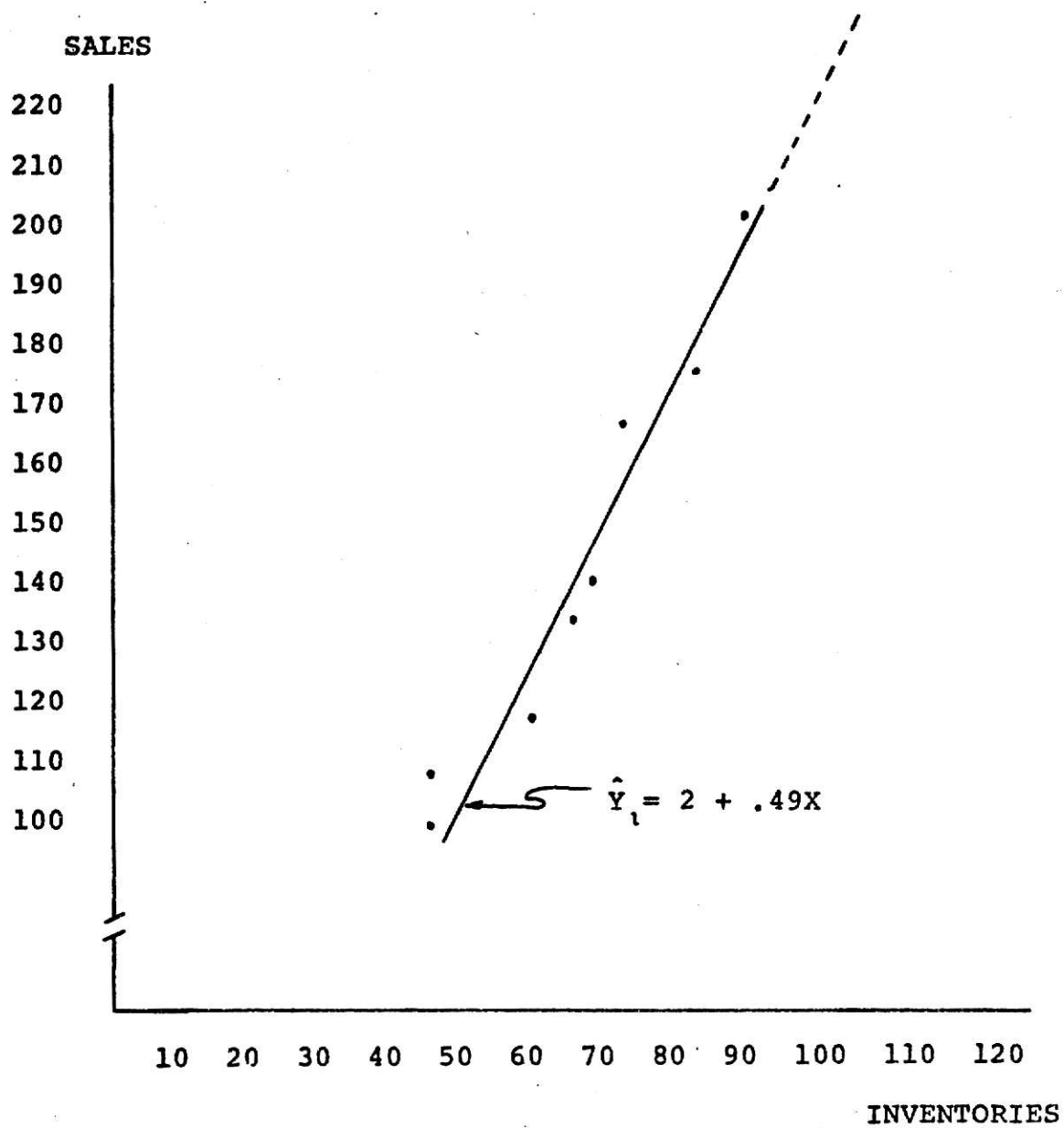


DIAGRAM II

THE REGRESSION OF INVENTORIES ON SALES

If sales levels equal the X values and the inventory levels equal the Y values the slope of the regression line becomes $\hat{Y}_1 = \bar{Y} + b (X_1 - \bar{X})$ where \hat{Y}_1 = the estimated value of Y's on the regression line, \bar{Y} = the mean of the observed Y values, b = the slope of the regression line, and \bar{X} = the mean of the X values observed. The value of b is calculated to be .49, and the value of \bar{Y} is likewise calculated to be 75.⁶ The computed value of \bar{X} is 149, and the regression equation is $\hat{Y}_1 = 2 + .49X$.

The regression line is drawn as a solid line in Diagram II. From this trend line, given the past errors in inventory decision making the future inventory needs in relation to sales may be predicted by extrapolation. It should be noted at this point that projection based upon past data states nothing about the relevance of the past relationships of inventories to sales. Although an evaluation of the factors that have caused past deviations from the trend line will not be attempted, it must be recognized that such deviation may have an influence on the subjective evaluation of potential future deviation from the projected trend.

Assuming that inventory decisions have been optimum in the past, the firm may use this regression equation to plan for future inventory investments. When the regression line has been extended for the planning period in question, the firm may wish to modify the slope or position based

⁶See Appendix A

upon foreseen changes in the derived relationship. For example, a firm may study current economic predictions of the government, academicians, and other knowledgeable individuals and, based upon this, modify the regression line.

This type of modification of the regression line should be based upon a probability distribution of the possible shifts in the line. In other words, more than one line should be used in relation to the computed regression line. For predictive purposes multiple estimates may be considered for decision making. Furthermore, the firm may wish to know the variance about the computed regression line or the correlation between X and Y expressed as a coefficient. The correlation coefficient and the variance, however, are similar concepts in that they both indicate how well the regression line fits the data points. The calculation of the correlation coefficient is made in Appendix B to satisfy the rigor of the analysis. In this case no problem arises as to the predictive validity of the regression line since the correlation coefficient is so high.⁷

Further modification of the regression line for predictive purposes might encompass changes in inventory policy based on past incorrect decisions. It is important, however, that all changes in the slope or position of the predictive trend line by the firm that are subject to a degree

⁷See Appendix B

of uncertainty should be expressed in a probability distribution function. If the firm is one hundred per cent certain that a change of a particular type should be made in the predicted trend line, then they need not express the new relationship in a probability distribution function.

The firm should express all other changes in the predicted trend line in a probability form. This is necessary to incorporate the uncertainty of the real world into the analysis. If an event is not certain, its prediction should not be expressed as one value. Instead of a single point estimate the probability of each possible outcome should be enumerated. In the final section of this report a hypothetical probability distribution function of predicted trend line changes will be constructed and used in the final model of the decision tree.

The firm must take a sample of the opinions of those people both within and outside of the firm as to what may cause the predicted trend line to be different from the derived regression line. These opinions must then be compiled into a distribution function. This assumes the use of subjective probabilities on the part of those who give opinions. This does not seem to weaken the decision making quality of this technique since in the final analysis all management decisions have in them some subjective judgement. This subjectivity is essential to managerial decisions providing it is based upon sound objective data.

Assume that the data from such a survey look as follows:⁸

Categories of Outcomes	A	B	C	D	E	F	G
Frequency of People in Each Category	1	4	6	18	6	4	1

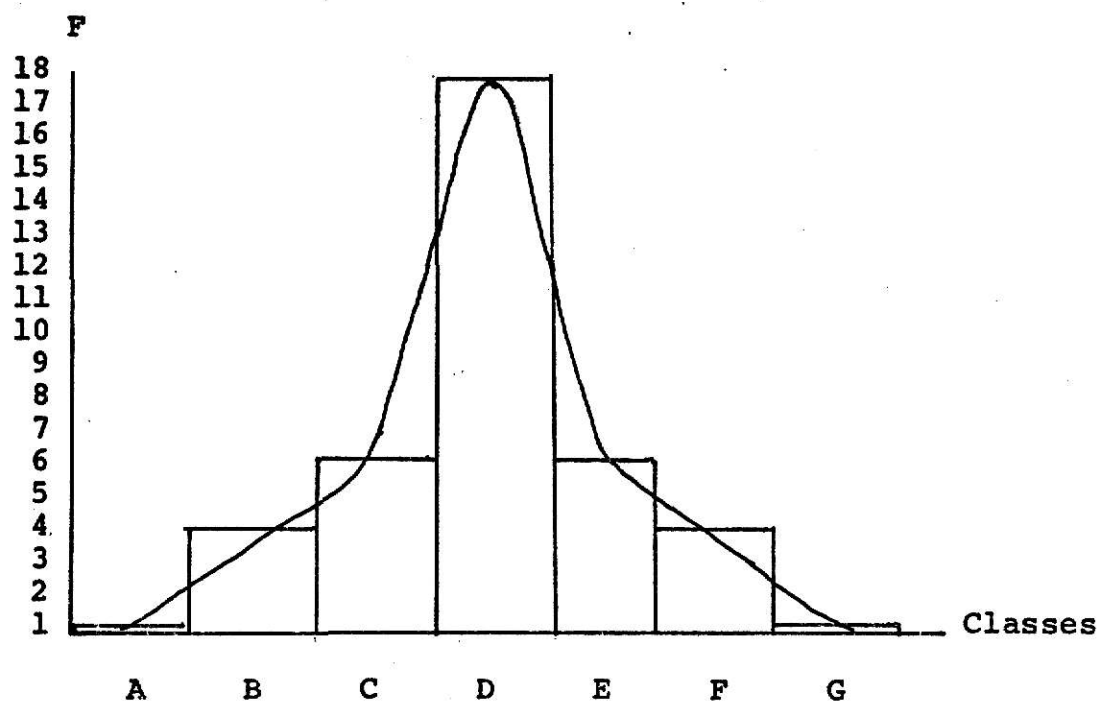


DIAGRAM III

PROBABILITY DISTRIBUTION

Diagram III may now be superimposed upon the regression line already computed. This will illustrate the probability distribution function of the estimates of the new predictor line. This may be done in the following manner:

⁸See Appendix C

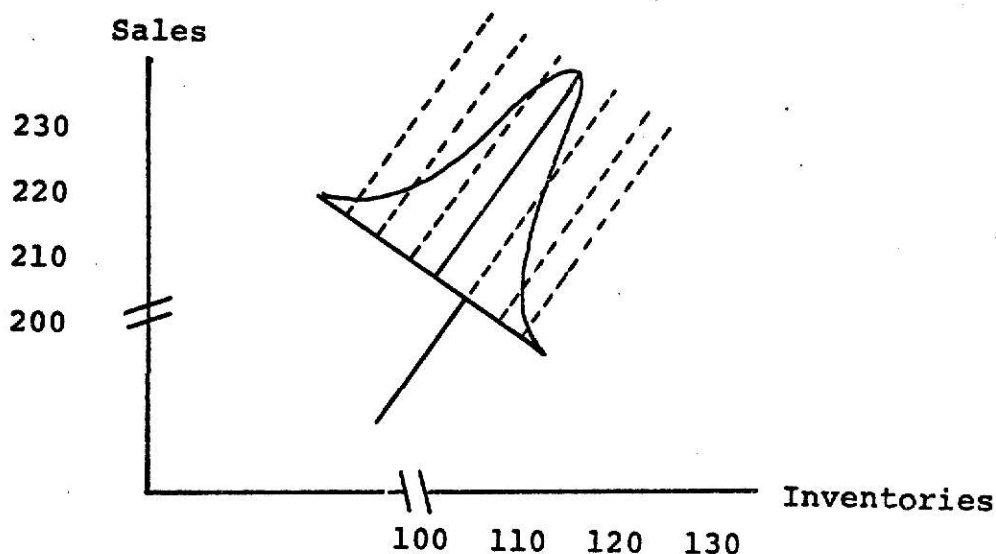


DIAGRAM IV

SUPERIMPOSED DISTRIBUTION OF DIAGRAM III (Yearly Basis)

Hypothetical probabilities will be used in place of calculated ones to illustrate the point. Assume that the probability of the mean of D class occurring is approximately .60. In other words the 90 per cent confidence interval on this mean indicates that the probability of mean occurring is .60 within a small confidence interval. Henceforth, when the probability of a mean is mentioned it will be assumed that this is approximate within a 90 per cent confidence interval. The approximation will be used for illustration purposes for simplicity's sake instead of the actual 90 per cent confidence interval parameters. This point is very significant statistically and must be remembered whenever a probability of a mean occurring is stated in this report.

Only the three greatest probabilities of changes in a prediction line will be used to keep the decision tree model illustrated in Chapter VI in a simple form.

The probability of the mean C occurring is assumed to be approximately .10. Likewise the assumed probability of the mean of E occurring is approximately .10. This is all that will be said at this point about the probabilities of events C, D and E occurring. These probabilities will be used in the last chapter of this report for the construction of a decision tree.

The firm must now consider the component time periods within a year in order to analyze the impact of shorter-term influences on the cash management process. First, as was done, inventory relationships to sales must be computed on a yearly basis to predict the yearly trend in the relation of a growth in sales with the growth of inventories. When this is accomplished the firm must then make the same type of predictions for each month or shorter period in the year. A firm will want to know in advance when excess cash will be available for short-term investments so they can make profitable investment decisions. By knowing the inventory flows and levels associated with the time period in question they have a start on solving their problem.

The procedure for this type of analysis is the same as that involved for the yearly basis. The depiction of such a case for the month of January may, for illustration purposes, look as follows:

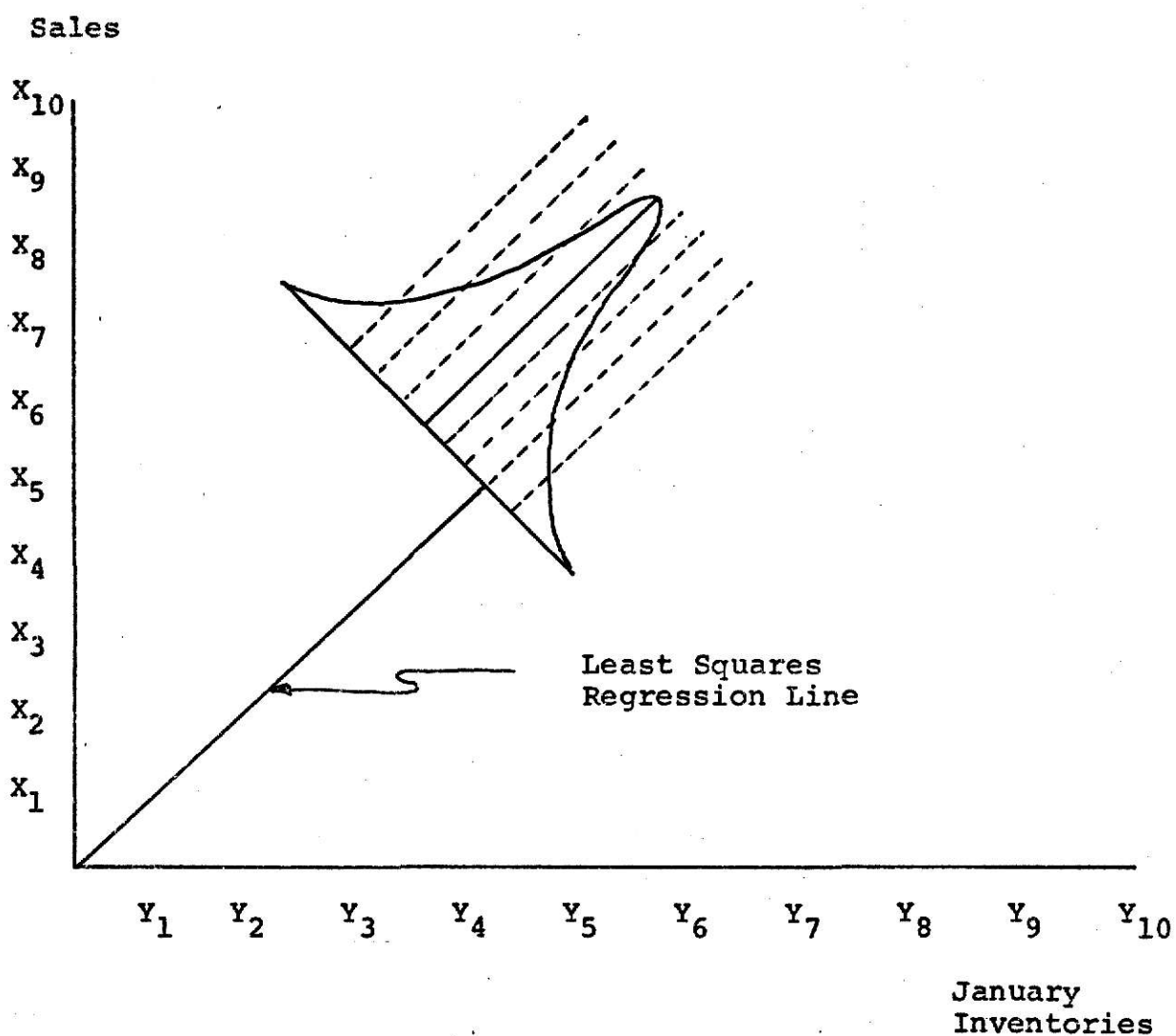


DIAGRAM V

SUPERIMPOSED DISTRIBUTION (Monthly Basis)

x_i = values of sales

y_i = values of inventories in corresponding years

Both $x_1 \dots x_5$ and $y_1 \dots y_5$ are for the 1964-1968 period from bottom to top and left to right respectively. The values beyond x_5 are for predicted years sales and those beyond y_5 are for predicted inventories.

Although the relation of inventory to sales has been of prime importance in the preceding discussion, it is the cash outflow associated with that inventory that the firm is concerned with for cash management purposes. Thus, the firm must consider the leads and lags associated with the payment for inventories purchased. In the previous analysis accounts payable were not used since they will be associated primarily with inventories. However, it is necessary for the firm to consider when they will pay for the inventories they purchase. This is usually a simple matter. Hereafter, when cash outflows for inventories are mentioned it will be assumed the firm is aware of the lead and lag problems. In other words, inventory cash needs may not be the same as the actual inventory on hand but most likely the cash needs will be associated with the inventory purchases the previous period.

Another note is important before closing this chapter. Although this discussion has been based upon inventory predictions, other cash outflows may be analyzed in a similar manner. Inventories were used in this section primarily for illustration purposes since they are frequently an important cause of cash outflows.

With this procedure the firm may now predict with probabilities what the inventory needs will be for short time periods. Thus, one major problem in solving the cash management problem is clarified. The firm can now predict the level and flow of the largest part of their current assets, in most cases, inventories.

The firm must now find the greatest source of cash inflows and try to predict the level and flows of this source. This source will, in most cases flow directly from accounts receivable.

CHAPTER III

THE INFLUENCE OF ACCOUNTS RECEIVABLE ON CASH MANAGEMENT

The Nature of Receivables

The nature of receivables is similar to that of inventories. A firm must try to predict the future levels and flows of receivables in relation to sales. The firm must also, in estimating future receivables, be aware of the significance of the yearly trend line in light of the monthly trend lines. The yearly regression line for receivables, like that of inventories, may hide within it monthly fluctuations that are of significance to the financial manager.

The firm must also recognize for prediction purposes that receivables represent lags between sales and collections. Although this is not a difficult problem to be solved, it must be recognized in the analysis.

This chapter on accounts receivables will be based upon the assumption that most of a firm's sales are credit sales. While this may or may not be true, the model will not be altered significantly if it is not true. If most of a firm's sales are cash sales, then it would only be necessary to find the probability of occurrence of a particular period's sales. This would determine the cash inflows and

could be matched against the period's outflows to predict the cash balance of that period. Thus, it appears to be a special case of the accounts receivable model to be employed here and, consequently, will receive no further attention.

Predicting the Receivables to Sales Relationships

The prediction of accounts receivable turnover and levels, as was mentioned previously, is carried out in a manner similar to that used for inventory prediction. The firm must find the relationship between receivables and sales. Assuming for illustration purposes that all sales are credit sales, this can be done by using the least squares regression method. Assume the historical points that relate sales and receivables are as depicted in Diagram VI. The line labeled \hat{Y}_1 is the least square regression line.

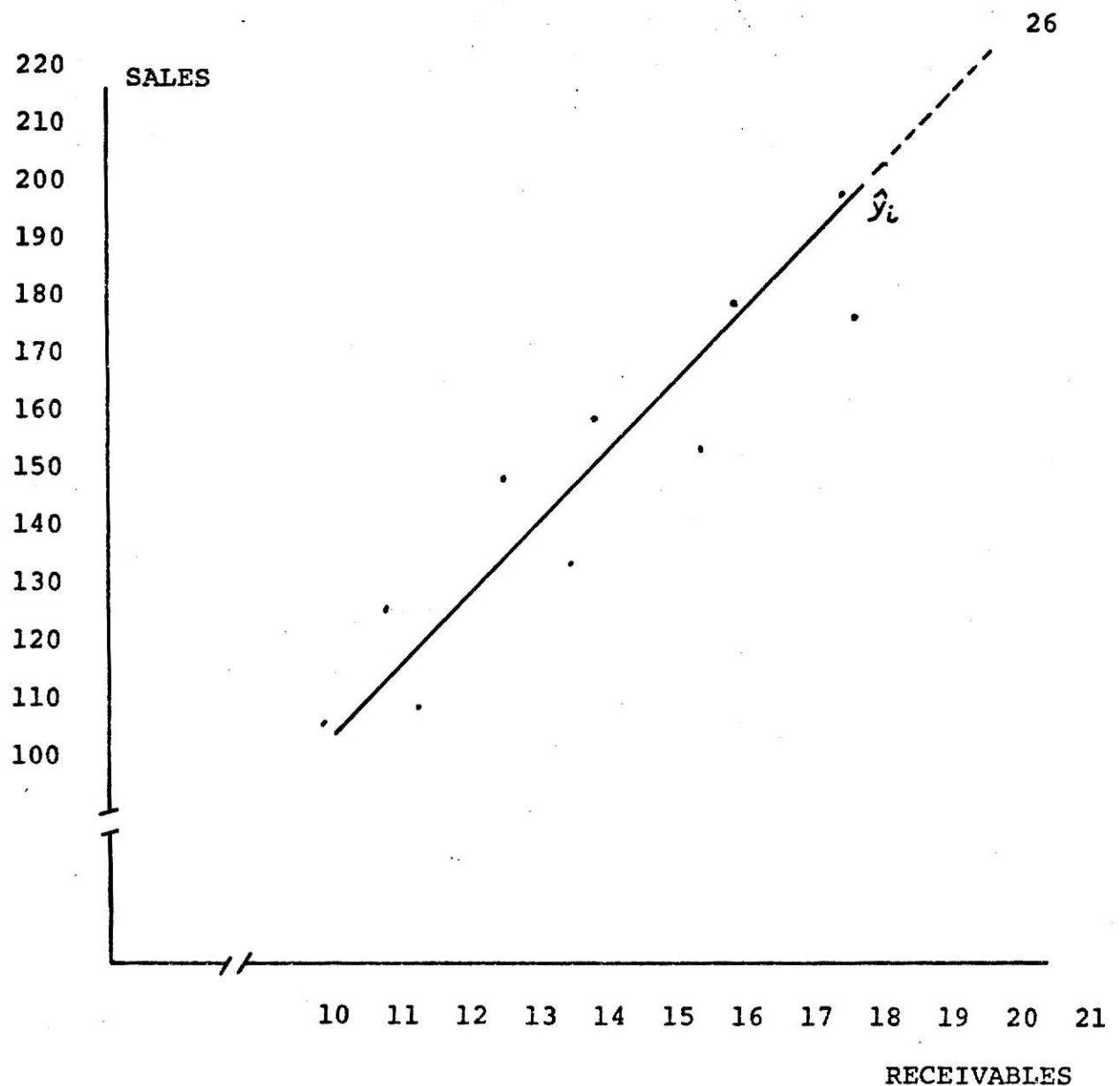


DIAGRAM VI
REGRESSION OF RECEIVABLES ON SALES

Without again going through the construction of a regression equation and the computation of a product moment coefficient of linear correlation, it is necessary to consider some aspects of this method in relation to accounts receivable. If the data appeared graphically as they do in

Diagram VI, the least squares method for prediction purpose may be questioned. The historical points show a fairly wide dispersion. Assume that the product moment coefficient of linear correlation is .65. The question arises as to whether the correlation is too low to accept \hat{Y}_1 as a good prediction baseline. This type of problem has several facets, none of which tend to be serious.

Each member of the staff of the firm who participates in the sample for the probability distribution function of future expectations will use \hat{Y}_1 only as a base line. This field is still wide open for incorporating the opinion of those sampled. If those sampled think that the regression line is of little value they may discount it in their prediction. This is one way in which the error of the regression line for predictive purposes is lessened.

A second factor will also refute the criticism of using a regression to predict the future relation of receivables to sales when the correlation coefficient is low. Once the yearly regression line is computed the firm must then predict on a monthly or shorter period basis. It seems unlikely that a firm would find a low correlation coefficient for the relation of monthly sales to monthly receivables over a period of years. If this were the case the problems will probably lie much deeper than cash management.

Therefore, it appears that the regression technique employed here survives the criticism of a potentially low correlation coefficient and may be used successfully for the prediction of future relationships.

It is now necessary to find the probability distribution associated with the opinions of those in the firm qualified to estimate future sales and receivables. For illustration purposes assume that this data appears as follows:

Categories of Outcomes	A	B	C	D	E	F	G
Frequency of People in Each Category	2	3	5	20	5	3	2

This data can be put into a distribution function similar to the inventory distribution illustrated in Diagram III and then superimposed on the regression line \hat{Y}_1 as follows:

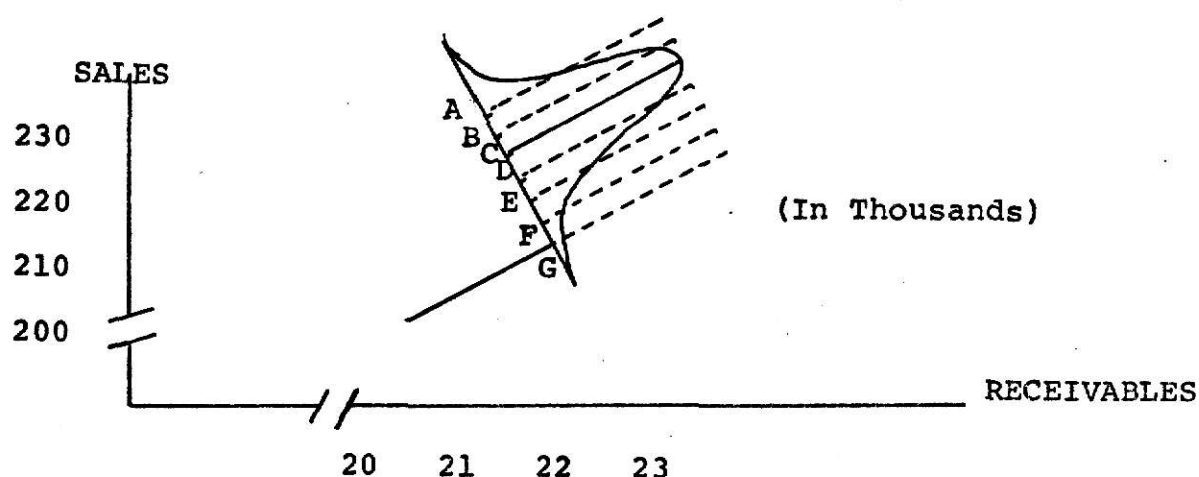


DIAGRAM VII

SUPERIMPOSED DISTRIBUTION OF RECEIVABLES
AND SALES RELATIONSHIPS

Assume the probability of the mean of class D occurring equals .60, C = .10, E = .10 and all others are not significant.⁹ As in the case of inventories only the three most significant probabilities will be used to construct the final decision tree to keep the model workable without a computer.

The firm is now ready to find the regression on a monthly basis for receivables. This will, as in the case of inventories, allow the firm to plan on a short-term, realistic basis for cash management purposes. When this step of receivables prediction is done the firm should have reasonably good estimates of the cash flows associated with the receivables investment for any particular period.

By considering the leads and lags of receivables and inventories within the framework of a regression analysis, it is possible to predict with a great deal of accuracy the major sources of contributions to and requirements on cash balances of the firm. However, there are constraints on this cash balance and the significance of these may be lost in the subjective probability estimates. Some of the more pertinent constraints must be identified and evaluated at this point.

⁹See Appendix D

The significance of the yearly restraints as well as those that exclusively affect a shorter time period must be considered for planning's sake. This is done for two reasons. First this breakdown and analysis will make periodic planning more realistic. Secondly, it is important for the firm to realize that there is no simple solution to the cash management problem. A firm cannot simply construct a regression line for inventories and receivables and their appropriate probability distributions and find the solution. There are important constraints upon the cash position of the firm. No matter what type of analysis is used these constraints must be kept foremost in the decision maker's mind.

CHAPTER IV

CONSTRAINTS ON THE CASH POSITION OF THE FIRM

The constraints on the firm's cash position are many and varied for all firms. This chapter will analyze what the author feels are the four most common and significant constraints on the cash position of most firms. These four constraints are the credit constraints, compensating balance constraints, loan clean-up constraints and liquidity preference constraints. Each of these will be discussed in the following sections of this chapter.

Credit Constraints

The first constraint upon the cash policy of a firm to be considered is the cost of an adverse credit rating. If for one reason or another a firm's credit rating falls, then they are incurring an additional cost. If this cost is greater than the advantage gained by an act that will lower the firm's credit rating, then profit is not maximized. An illustration will show this type of situation quite clearly. The following assumptions are made for this analysis. Firm A purchases approximately two hundred thousand dollars per year in goods from firm B. The credit arrangement between firm A and B is that A may pay B on a 2/10; net/30 basis. Firm A has the opportunity to sell to firm C two hundred

thousand dollars worth of merchandise. In order for firm A to make this sale to firm C, however, it must forgo paying a liability due to B. Assume also that the extension of this credit without B's approval causes B to sell no longer to A on a 2/10; net/30 basis. Firm A estimates that the net operating margin on a sale to C will be approximately twenty per cent.¹⁰ The profitability of such a decision to sell to C might look as follows for A:

TABLE II

EXPLICIT COSTS OF CREDIT

Description	Terms of Agreement	Yearly Interest	Results
B sells to A	2/10; net/30	36%	
A sells to C	20% Net Operating Margin	20%	
Loss of A in Relation to B			16%

Table II sets forth the explicit costs to firm A for extending their credit too far. This extension of credit to the point of lowering a firm's credit rating in the eyes

¹⁰ It is assumed that the quantity of cash required by firm A to finance the manufacture and sale of goods to firm C is equal to that owed to firm B.

of its creditors and thus incurring explicit or implicit costs will be referred to as a violation of the "critical credit minimum". Therefore, the "critical credit minimum" is the point at which, by extending the use of credit, the firm requesting the credit incurs credit costs. Whenever the "critical credit minimum" is violated, costs will be incurred and losses may ensue. The firm must try to calculate the implicit as well as the explicit costs in such a case. The benefits, both implicit and explicit, must be measured and compared to the relevant costs. This type of approach fits the cash management decision into the profit model.

This example is just one of the many ways in which a firm may violate the "critical credit minimum" and incur costs from doing so. Some costs, mainly implicit costs, will be difficult for the firm to determine, but a thorough effort must be made nevertheless. By estimating costs and benefits and weighing their relative importance the firm can accomplish the profit objective.

Compensating Balance Constraints

The second important constraint upon the cash management of a firm, compensating balance requirements, is, in part, an external one. The decision to maintain a compensating balance will depend upon five factors. These five factors are the firm's transaction demand for money, precautionary demand

for money, speculative demand for money, the bank's deposit balance requirements for servicing such demands and the borrowing rate of the firm.

It is obvious that the first three factors are components of the liquidity preference function of the firm. In this section however, these three factors will be considered in light of the compensating balance requirements only. A compilation of the total liquidity preference of the firm will be examined in detail in the next section of this chapter.

Assume that (1) a firm has an average monthly transaction demand for cash of fifty thousand dollars, (2) the firm has a line of credit with the bank of forty-five thousand dollars to supply part of the firm's transaction demand for cash and (3) that the bank requires a five thousand dollar compensating balance for this service. This means that, if the firm wishes to insure a source of readily available funds for transaction purposes, it must maintain a five thousand dollar balance at all times with its bank.

The firm must feel that the transaction demand for cash is sufficient to require this compensating balance. This decision involves the firm's realizing what "short costs" could be if the credit line did not exist and weighing them against the cost and benefits of the credit line.

If the firm, as most firms do, feels a need for liquidity to meet contingencies then it is necessary for them to analyze their precautionary demand for cash. A firm might determine that unpredictable net cash outflows could exceed the transaction balance provision by as much as eight thousand dollars on any particular day. The bank might require that the firm maintain an additional one thousand dollars in a deposit (compensating) balance for an additional credit line of five thousand dollars to finance part of the precautionary demand. This case again becomes one of calculating the possible "short costs" involved if the firm did not maintain this balance and weighing them against the advantages and costs of maintaining the balance.

The firm may also demand cash for speculative purposes. Assume that the average monthly amount demanded by the firm for speculative purposes is two thousand dollars. The bank is willing to finance one thousand dollars of this with a line of credit. The bank requires a compensating balance of three hundred dollars for this service. The data for the firm just described is summarized in tabular form in columns three and four and rows one through four of Table III.

If the firm does not maintain an acceptable compensating balance with its bank, its credit rating may suffer. This may cause the firm's future borrowing rate to increase. An increase in the borrowing rate may take the form of either a higher interest rate on an existing credit line or a larger

TABLE III
THE COMPENSATING BALANCE
AND THE LIQUIDITY PREFERENCE CONSTRAINT

Demand Category	Borrowing rate of the firm	Total liquidity needs	Credit line	Compensating balance	Other liquidity balance	Total balance for liquidity purposes
Transaction Demand	5.8%	\$50,000	\$45,000	\$5,000	\$5,000	\$10,000
Precautionary Demand	5.8	11,000	8,000	1,000	3,000	4,000
Speculative Demand	5.8	2,000	1,000	300	1,000	1,300
Total Demand Case I	5.8	62,100	54,000	6,300	8,100	14,400
Total Demand Case II	5.5	66,500	58,000	6,900	8,500	15,400
Total Demand Case III	5.3	74,000	65,000	7,400	9,000	16,400
Total Demand Case IV	5.2	79,700	70,000	7,900	9,700	17,600

compensating balance requirement per dollar of credit line granted by the bank. If the firm is unable or unwilling to meet the bank's compensating balance requirement, its credit line may be curtailed or even cancelled. This may result in severe short costs associated with the firm not being able to meet its cash needs for transactions, precautionary or speculative purposes.

The Liquidity Constraint

In the illustration used in the previous section of this chapter the firm's total compensating balance requirement to maintain a credit line of fifty-four thousand dollars was six thousand three hundred dollars.¹¹ This credit line was not sufficient to meet the firm's total liquidity needs of \$62,100. The firm must acquire other funds of \$8,100 to meet their total liquidity needs. The actual balance of cash or near cash that this firm must maintain in Case I is \$14,400. This involves a compensating balance of \$6,300 and other cash or short term investments of \$8,100 (row 4, column 5, Table III).

¹¹It is assumed that the compensating balance requirements are stated in terms of a minimum monthly balance and not an average balance.

The level of cash and near cash balances to be held by the firm will depend upon the liquidity preferences of the final decision maker in this area and the liquidity preferences of others in the firm's management that influence his decisions. It becomes quite apparent that the liquidity constraint is a function not only of the decision maker's liquidity preference but also of liquidity preferences of those who influence his decisions.

Assume that the data in columns one through six and rows one through four in Table III represent the current position of the firm. Assume further that if the borrowing rate for the firm falls as in Case II, Case III, and Case IV, the corresponding data in Table III for these cases can be predicted with a probability of .90.¹² This can be illustrated graphically in a liquidity preference function as in Diagram VIII.

¹²The effective borrowing rate to the firm is determined not only by the explicit interest charge quoted by the lender but also by the cost of additional compensating balances that must be held to support the credit line and by adjustments in the minimum rate of return required by the owners as a result of the use of debt financing. Therefore, the borrowing rates must represent estimates of the firm's cost of capital.

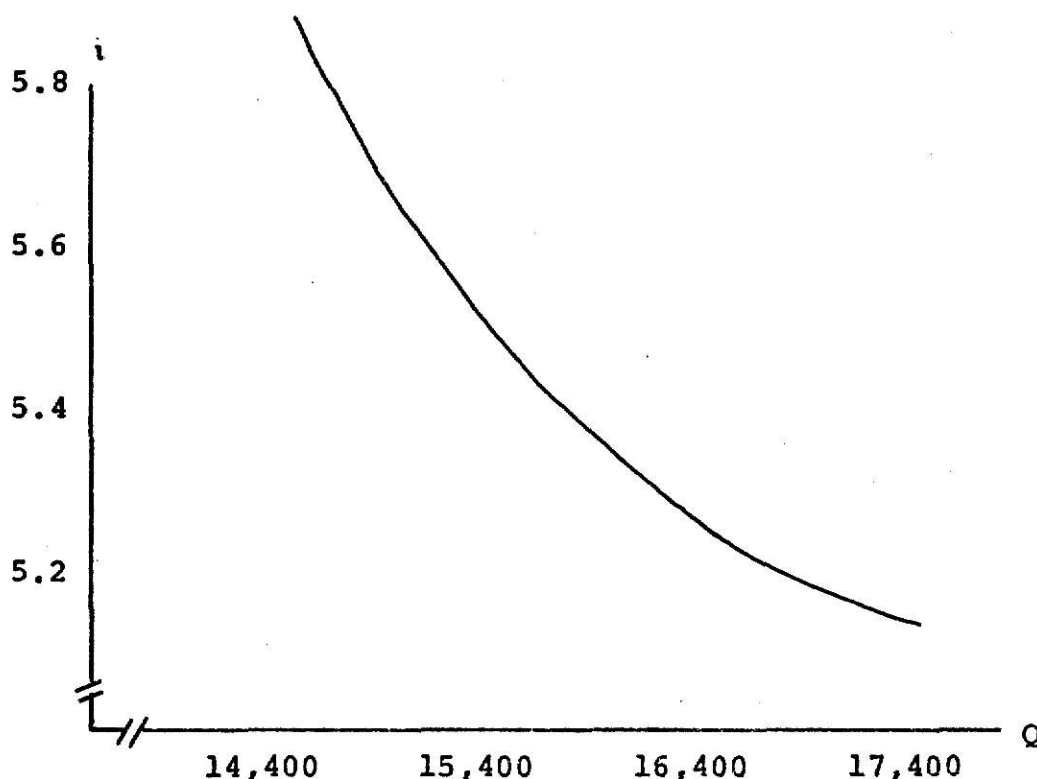


DIAGRAM VIII

LIQUIDITY PREFERENCE

Q = the quantity of liquidity demanded by the firm

i = the financing rate for the firm

The function L_{WA} represents the liquidity preference schedule that underlies the cash management decisions in the firm. This function considers the total impact of (1) the transactions, precautionary and speculative demands for money, (2) the compensatory balance requirements of the bank and (3) the borrowing rate of the firm on the liquidity constraints imposed on a firm's liquidity (cash) management decisions.

It should be pointed out that estimates of the type made above for a liquidity preference function must recognize the possibility of alternative outcomes. The slope and position of the liquidity preference function would be based upon subjective and objective estimates by persons inside and outside the firm of the demands for money, the balances required by the bank and the costs of financing these liquidity requirements. A probability distribution of the alternative outcomes must be set up and those using such data must understand the assumptions that lie behind this distribution of predicted liquidity investments.

The individual who makes the final liquidity decisions may base his judgements on a compilation and analysis of the probability estimates submitted by the managers involved with the liquidity management problem. Alternatively, the individual may rely on an intuitive feel for the liquidity preferences held by this management group. The latter approach can be dangerous. Subjective judgements should be scrutinized carefully to assure that the manager does not simply follow his personal preferences rather than the collective judgement of the management group.

The Clean-Up Constraint

The fourth major constraint that has a significant impact on the cash management of a firm is the clean-up constraint. This constraint requires loans to be cleaned up

during a specified period. In other words, the bank or other creditors may demand that during a specified period each year a firm must pay off all its loan. For example, a firm may borrow fifty thousand dollars per year to finance a portion of their inventory investment. The bank may require that this loan be liquidated for the months of February and March of each year.

The problem of cleaning up loans may be greatly lessened if the firm has borrowing arrangements with several banks. Even if this is the case, managers of the firm must be cognizant of these clean-up periods and amounts. These periods must be anticipated and planned for. A violation of this constraint may lead to serious "short costs" to the firm.

Firms may negotiate with their banks for the best terms possible in such clean-up arrangements; however, this is not to be considered here. This, as important as it is as a financing problem, is outside the scope of cash management. The important point in this chapter is to establish the major constraints on cash management and to illustrate how these constraints could be incorporated in a probability distribution function so that further study of the problem is possible.

A firm could project its liquidity requirements by superimposing a probability distribution function on the projection of a trend line derived through a regression analysis. If the specific period by period constraints are

ignored, however, the firm may be in serious trouble. To illustrate this point, assume that the firm has projected, by techniques previously discussed, the most likely outcome of the next year's cash needs. Further assume that the firm has prepared a projection of the potential cash needs for the month of February in that year. Based upon past experience and a projection of the future experience, it appears that the average cash level required to support operations for the month of February is twenty-five thousand dollars. The firm's prior financing arrangements also require it to clean up a five thousand dollar loan during February. If management did not consider this constraint in making its original projection, the firm could be five thousand dollars short of cash in the month of February.

Thus, it is essential that firms keep updating period by period their data on the cash flows and the cash constraints. By doing this the firm can keep a constant watch on their cash requirements and be prepared to meet them.

Finally, when the firm has determined its most probable cash needs, it may turn to the problem of financing cash shortages and investing excess cash balances. The following chapter points out some of the alternatives for the firm when there is a disparity between cash needs and cash levels.

CHAPTER V

EXCESS CASH, INSUFFICIENT CASH AND SHORT TERM INVESTMENT POLICY

Insufficient Cash

If a firm has insufficient internally generated cash to meet its needs it may seek funds from a variety of sources.¹³ These sources include short-term bank loans, extension of current liabilities, liquidation of short-term securities, lines of credit, revolving loans and a host of other arrangements. The variety of short-term funds available to firms is limited only by the imagination of the financial manager.

Financing of projected cash deficits can be a crucial problem for a business firm. This presentation will not elaborate on the problem, however, since a detailed discussion on the variety and characteristics of sources for short-term financing is outside the scope of this report. The important point to note is that the financial manager must plan the firm's needs for such financing in order to assure that (1) funds will be available at the best terms to the firm and (2) the benefits to be derived from investing these funds will justify the cost of financing.

¹³See Jerome B. Cohen and Sidney M. Robbins, The Financial Manager (New York: Harper and Row Company, 1966), Chapter 13.

Excess Cash and Short Term Investment Policy

The second section of this chapter, excess cash and short-term investment policies, may now be developed. It is necessary for the financial manager to be aware of his short-term investment alternatives. Surprisingly enough a failure to invest excess cash in short-term securities seems to be the rule rather than the exception with many firms.

A firm may estimate the potential range of yields expected on alternative types of short-term securities classified according to maturity dates. Probability distribution of these estimated yields will be helpful to the financial manager in planning the investment of excess cash balances. These projections may be fit quite easily into a final decision model, the decision tree.

Assume for purposes of examining a concrete case that the following is true.

TABLE IV¹⁴

RELATIVE YIELD, SAFETY, LIQUIDITY AND MATURITY
OF SHORT-TERM SECURITIES

No.	Type of Security	Safety	Liquidity	Maturity	Predicted Yield (90% Confidence)	
1	Treasury Bills	1	1	1	9	5.22%
2	U.S. Treasury Notes	2	2	7	8	5.36%
3	Federal Agencies Securities	5	4	6	6	5.55%
4	PHA Notes	3	3	4	2	6.66%
5	State and Local Bonds	4	5	5	1	7.50%
6	Banker's Acceptance	6	8	1	5	5.65%
7	Line Certificate of Deposit	6	6	2	7	5.45%
8	90 Day Finance Company Paper	7	9	1	4	5.88%
9	Commercial Paper	6	7	3	3	6.0%

1 = safest, most liquid, shortest maturity, highest yield

¹⁴See Edward J. Mock et al., Basic Financial Management (Scranton, Pennsylvania: International Textbook Company, 1968), p. 116.

Table IV gives the various important characteristics of short-term securities that are available to the firm. These data can be used by a firm to set up systems of security investment policy that will best suit their needs.

Assume that, based upon Table IV, the decision makers of the firm now give their opinions as to which investment they think will be the most profitable. Involved in this estimate is each member's prediction of (1) how much the yield on a particular investment may vary from the mean-yield presented in Table IV and (2) which investment alternative is likely to be the most desirable once the risk characteristics are also considered. Assume that this survey resulted in the following frequency distribution.

Number 1-9	7	6	4	2	1	3	5	9	8
Prob. of Occurrence	.02	.03	.05	.10	.60	.10	.05	.03	.02

Again using the three most likely probabilities the firm may set these aside to use in a decision tree later. The firm uses a risk-adjusted profitability index. Much emphasis is put on liquidity for this firm; therefore, the most desirable short-term investments may not be those with the highest interest rate. By the survey it has been determined that Treasury Bills have the highest profit potential for the firm once the predicted yields are adjusted by a risk factor. Treasury Notes and Federal Agencies Securities have the second highest probabilities for being the

most profitable. It is obvious that these securities are not the highest yielding on a true percentage basis. However, for this particular firm it seems more profitable to compromise some of the yield on the securities for a higher profit in general from being liquid. This may, of course, vary from firm to firm.

The firm is now ready to take all of the data compiled above and form a decision tree for the final solution to their cash management problems.

CHAPTER VI

THE INTEGRATED CASH MANAGEMENT

DECISION

This final chapter is designed to give the firm an integrated model of the cash management problem. Before the final model is considered a brief summary of what has already been done will be helpful to lay the foundation for the model in its final form.

Summary

The firm has compiled and analyzed its inventory data. The projection of these data in a probability distribution function which has been superimposed on a trend line derived from a regression of Inventories on Sales (Diagram IV, page 19) has given the firm an indication of its expected inventory position. This inventory position was examined both on a yearly and a monthly basis to make planning realistic.

The firm then turned to the problem of predicting receivables flows. Data was compiled and estimates made about the nature of accounts receivable for the next year. This was also broken down into a monthly, or shorter, time period for more practical analysis.

The firm considered the individual constraints on cash management for each period involved. This is a vital link in the chain of events for proper cash management. If constraints

are ignored, innumerable short costs may be incurred. If this occurs the previous effort of inventory and receivables analysis is of little value.

With these areas set forth clearly, the firm may begin to plan what they will do about excess cash or insufficient cash. The firm may invest cash in short-term securities with the overall profit objective in mind. This cash may be invested in lower yielding securities that are more liquid, or safer, so that the firm will be more profitable in the overall analysis. If the firm has insufficient cash they must make arrangements through various sources to secure the needed cash. The firm must be careful to borrow in such a manner that minimizes "short costs" in order to maximize profits.

A decision tree may be used to point out the complexity of the cash management decision and to put it into a comprehensive picture. This decision tree indicates the possible relationships among the individual cash management decisions and the final impact of such decision on the profit objective.

In using a decision tree as a final model of cash management, a firm must realize what lies behind it. The individual probabilities in the decision tree must be developed in a careful and systematic manner. If the derivation of these probabilities is based on poor statistical procedures or incompetent data collection then they are not worthy of consideration. The decision tree is only a final product of

much previous study.

The Final Model

The decision tree used for this report will only make use of the three most probable events in each probability distribution computed. This is done to keep the analysis to a manageable level. This is for illustration only. The firm could easily extend their decision tree to include any number of the probabilities in the distribution with the aid of the computer. Suppose for the sake of simplicity that the firm's decision tree looks as follows:

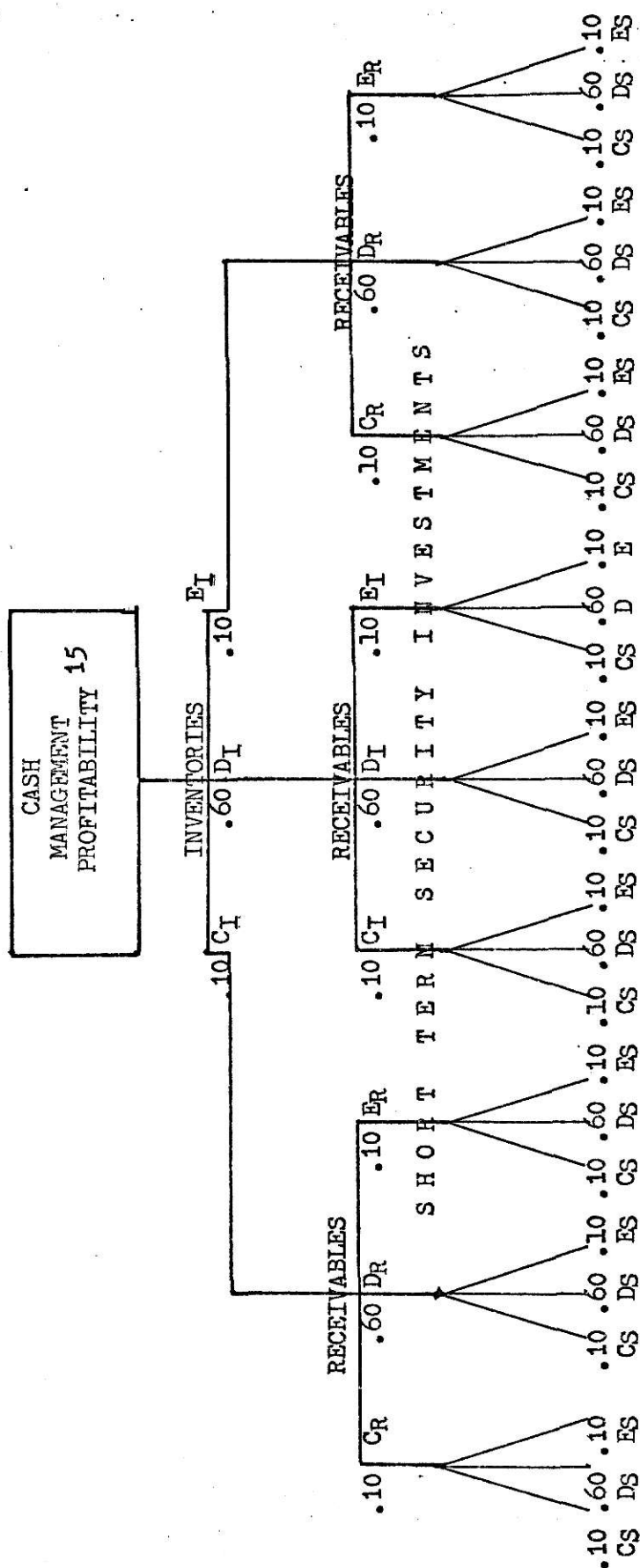


DIAGRAM IX

THE DECISION TREE

15 The categories of outcomes are designated as C, D, E. The subscripts of these outcomes indicate what variable they are associated with. The subscript I indicates inventories, R indicates receivables and S indicates securities. If there is no excess cash for short-term investment purposes the decision branches designated with subscripts will not be used. The final decision is made at the level immediately preceding this.

A firm could construct a decision tree of this type in order to analyze the data projected for the following year's operations. This analysis could then lead to a policy decision on the cash management procedures to be followed. For purposes of illustration, assume that this analysis and the subsequent decision have already been made. Based on this information, the decision tree presented on the preceeding page has been prepared for a specific month within the forecast year. The data for the monthly projections are as follows:

TABLE V

DECISION TREE COMPONENTS

Inventories = I			Receivables = R			Security Desirability = S		
Cate- gory	Proba- bility	(\$) ¹ Flows ¹ Change in ⁴ Inventory Investment (i)	Cate- gory	Proba- bility	(\$) ² Flows ² Change in ³ Receivables Investment (r)	Cate- gory	Proba- bility	Yield (%) ³
CI	.10	\$3,000 + 1,000	CR	.10	\$5,000 0	CS	.10	5.36%
DI	.60	4,000 0	DR	.60	4,000 0	DS	.60	5.22
EI	.10	5,000 0	ER	.10	5,000 + 1,000	ES	.10	5.55

This data corresponds to a specific level of sales for a given month.

¹Net cash outflow required to support the usual investments in inventories during this time period.

²Net cash inflow resulting from a liquidation of the usual portion of the investment in receivables during this time period.

³The effective yield on a temporary investment of idle funds in short-term, marketable securities.

⁴Net cash outflow required to support an incremental investment in inventories.

⁵Net cash outflow required to support an incremental investment in receivables.

The firm must now fit these data into the decision tree, compute the outcomes and make an analysis of the cash position of the firm for the month. In this decision tree there are thirty-six possible outcomes.¹⁶ The firm must compute each of these outcomes, compare the alternatives and make their final decision. Assume that "short costs" are a linear function of the dollar volume violation of the "critical minimum".¹⁷ Thus if one plans for a particular path the probability of "short costs" occurring will vary inversely with the probability that path will occur. In order to illustrate this process, three of the possible outcomes will be computed and compared.

Case I will consider the potential outcome if the combination of alternatives D_R , C_I and E_S should occur. If this path occurs, the outcome will be as follows:

$$[D_R - C_I - 1] * E_S = \text{the profitability of this decision route (ie) } [\$5,000 - \$1,000 - \$3,000] * 5.55\% = \underline{\underline{\$55.50}}$$

In this case outflows of cash into inventories is less than the inflow of cash from receivables. Thus there is a \$1,000 net cash inflow. This excess cash may be invested in short-term securities to yield \$55.50 in returns.

¹⁶ See Appendix E

¹⁷ This relationship may be non-linear but is assumed to be linear here for simplicity's sake.

The probability of this path occurring is the joint probabilities of D_R , C_I and E_S . Therefore $P(D_R \cap C_I \cap E_S) = P(D_R) * P(C_I) * P(E_S) = (.60) (.10) (.10) = \underline{.006}$ = the probability of receiving the \$55.50 yield. Assume the "short costs" associated with not meeting these requirements is estimated to be \$60.00.

Case II will consider the potential outcome if the combination of alternatives D_R and D_I should occur. If this path occurs, the outcome will be as follows:
 $[D_R - D_I] =$ the profitability of this decision route (ie)
 $[\$4,000 - \$4,000] = \underline{0}$ This case illustrates a situation where cash inflows from receivables is equal to cash outflows into inventories. The joint probability of D_R and D_I occurring is $P(D_R \cap D_I) = (.60) (.60) = .36$. The assumed "short costs" associated with not meeting these requirements is \$20.00.

Case III will consider the potential outcome if the combination of alternatives D_R , E_I A and B should occur. A is assumed to be an average rate of return on the firm's investment. B is assumed to be the borrowing rate of the firm. The profitability path looks as follows:

$[D_R - E_I - r] * [A - B] = [\$5,000 - \$1,000 - \$5,000] * [7.5\% - 5.6\%] = \underline{\$38.00}$ In this case cash outflows into inventory and receivable investments are greater than cash inflows from receivables. Thus the firm must finance this investment at a rate of 5.6% assuming that this investment will earn at a rate of 7.5%. The joint probability of D_R , E_I , A and B

occurring is $P(D_R \cap E_I \cap A \cap B) = (.60) (.10) (1) (1) = \underline{\underline{.06}}$.

This assumes the probability of both A and B are one. The assumed "short costs" of not meeting these requirements is \$40.00.

The data for the three cases can be summarized for further analysis as follows:

Case	Probability	Potential Profitability	Potential Short Costs
Case I	.006	\$55.50	\$60.00
Case II	.36	None	20.00
Case III	.060	38.00	40.00

It can easily be seen that while Case I is the most profitable it is also the least probable. Case II is the least profitable and also the most probable. Case III is less probable than Case II but more probable than Case I. Therefore, it becomes quite apparent that the manager must still make a decision as to which path he plans for, and consequently how he defines his "critical minimum".

If the manager wanted to take the risk of Case I occurring to get the greatest profits, he may end up losing. Short costs of \$60.00 may be incurred if Case I does not in fact occur. On the other hand if the manager wished to take as little risk as possible for no gain he may plan for Case II. Thus his actual profits may be larger in Case II than in Case I since there is less chance for short costs, and short costs

are lower. Therefore in the end the manager may accept more risk for greater return than Case II and less than Case I and hence plan for Case III.

These three cases illustrate how the manager might take all thirty-six cases in the decision tree and evaluate them. This manager must take these possibilities and then determine what is the "critical minimum" cash balance necessary to support the firm's plans for a particular path. For example in Case III the firm must be able to acquire financing so as not to incur "short costs" if the additional inventory investment cannot be financed.

Conclusions

It can now be seen that this model does not automatically make the manager's decision. This method of selecting probable outcomes previously described makes it possible for the financial manager to define the "critical minimum". When this model is complete individual judgement must then be exercised. Further, this model in no way restricts the decisions of the manager. Instead, by using probabilities, it gives the decision maker an estimate of the possible outcomes. The model does eliminate single estimates for decision making. It also eliminates using the high, medium and low estimates currently adopted by some firms. Instead it uses probability statements which show, with ninety per cent accuracy, what the outcome may be.

In conclusion it should be noted that the model does not attempt to outline all of the decision variables. It is a suboptimizing segment of the total wealth maximizing concept for the firm, and it must be integrated into a more comprehensive model for the firm to achieve its total wealth maximizing objective. In this report only the basic model is explained. The other variables in a particular firm's case may be designed into this model easily if the concept of the basic model is understood and followed.

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APPENDIX

APPENDIX A

Computation of the Least Squares Regression Line

$$\bar{Y} = \frac{\sum Y_i}{n} = \frac{750}{10} = 75$$

$$\bar{X} = \frac{\sum X_i}{n} = \frac{1490}{10} = 149$$

$$b = \frac{\sum [(X_i - \bar{X})(Y_i - \bar{Y})]}{\sum [(X_i - \bar{X})^2]} = \frac{5,225}{10,690} = .49$$

Y	X	$X_i - \bar{X}$	$Y_i - \bar{Y}$	$(X_i - \bar{X})(Y_i - \bar{Y})$	$(X_i - \bar{X})^2$	\hat{Y}_i
50	100	-49	-25	1225	2401	51
50	110	-39	-25	975	1521	56
65	120	-29	-10	290	841	62
70	135	-14	-5	70	196	68
75	140	-9	0	0	81	71
75	150	1	0	0	1	76
80	165	16	5	80	256	83
90	175	26	15	390	676	87
95	195	46	20	920	2116	98
<u>100</u>	<u>200</u>	<u>51</u>	<u>25</u>	<u>1275</u>	<u>2601</u>	100
750	1490			5225	10,690	

$$\hat{Y}_i = 75 + .49 (X_i - 149)$$

$$= 2 + .49 X_i$$

APPENDIX B

PRODUCT MOMENT COEFFICIENT
OF LINEAR CORRELATION

The product moment coefficient of linear correlation is symbolized as r_p .

$$r_p = \frac{\sum X_1 Y_1 - \frac{\sum X_1 \sum Y_1}{n}}{\sqrt{(\sum X_1^2 - n\bar{X}^2)(\sum Y_1^2 - n\bar{Y}^2)}}$$

X_1	Y_1	$(X_1 Y_1)$	X_1^2	Y_1^2
100	50	5,000	10,000	2,500
110	50	5,500	12,100	2,500
120	65	7,800	14,400	4,225
135	70	9,450	18,225	4,900
140	75	10,500	19,600	5,625
150	75	11,250	22,500	5,625
165	80	13,200	27,225	6,400
175	90	15,750	30,625	8,100
195	95	18,525	38,025	9,025
200	100	20,000	40,000	10,000
750	1,490	116,975	232,700	58,900

$$r_p = \frac{116,975 - \frac{1,117,500}{10}}{\sqrt{(232,700 - 222,010)(58,900 - 56,250)}}$$

$$= \frac{5,225}{\sqrt{28,328,500}} = \frac{5,225}{5,322}$$

$$r_p = .98$$

APPENDIX C

FREQUENCY DISTRIBUTION OF EXPECTED CHANGES
IN INVENTORY PREDICTION LINE

For actual use this normal distribution would have to be transformed into a standard normal distribution - $N(0, 1)$. Then the approximate probabilities for the categories A-G could be assigned. It would be these probabilities that would appear in the decision tree. To avoid lengthy mathematical computation hypothetical probabilities will be used in the example in the text of the report.

The categories A-G are defined as follows:

A = The opinions of one segment of those interviewed that thought that the prediction line should be parallel and ten to eleven units to the left of what it is now for inventories.

B = Those who predicted the new line 8-9 units to the left of the regression line.

C = Those who predicted the line would have a 1 degree greater slope and be 6-7 units to the left of the regression line.

D = Those who predicted the line would have the same slope but shift to be 4-5 units to the left of the regression line.

E = Those who predicted the line would have a two degree greater slope and shift to be 2-3 units to the left of the regression line.

F = Those who predict the line will have the same slope but shift to be 2-3 units to the right of the regression line.

G = Those who predicted the line will shift to be 4-5 units to the right of the regression line.

APPENDIX D

For actual use this distribution, like that described in appendix C, would have to be transformed into a $N(0, 1)$.

The Categories A - G are defined as follows for Receivables.

A = The opinion of one segment of those interviewed that estimated the prediction line would shift to the left 11-12 units.

B = Those who predicted the trend line to be 9-10 units to the left of \hat{Y}_1 .

C = Those who predicted the trend line to be 7-8 units to the left of \hat{Y}_1 and have a 1^0 greater slope.

D = Those who predicted the trend line would have the same slope but be 5-6 units to the left of \hat{Y}_1 .

E = Those who predicted the trend line would increase 1^0 in slope and shift to 3-4 units to the left of \hat{Y}_1 .

F = Those who predicted the trend line would have the same slope but shift 1-2 units to the left.

G = Those who predicted the trend line would shift 1-2 units to the right with the same slope.

APPENDIX E

All Possible Outcomes in Decision Tree

1. $C_I C_R C_S$	13. $D_I C_R C_S$	25. $E_I C_R C_S$
2. $C_I C_R D_S$	14. $D_I C_R D_S$	26. $E_I C_R D_S$
3. $C_I C_R E_S$	15. $D_I C_R E_S$	27. $E_I C_R E_S$
4. $C_I C_R$	16. $D_I C_R$	28. $E_I C_R$
5. $C_I D_R C_S$	17. $D_I D_R C_S$	29. $E_I D_R C_S$
6. $C_I D_R D_S$	18. $D_I D_R D_S$	30. $E_I D_R D_S$
*7. $C_I D_R E_S$	*19. $D_I D_R E_S$	31. $E_I D_R E_S$
8. $C_I D_R$	20. $D_I D_R$	*32. $E_I D_R$
9. $C_I E_R C_S$	21. $D_I E_R C_S$	33. $E_I E_R C_S$
10. $C_I E_R D_S$	22. $D_I E_R D_S$	34. $E_I E_R D_S$
11. $C_I E_R E_S$	23. $D_I E_R E_S$	35. $E_I E_R E_S$
12. $C_I E_R$	24. $D_I E_R$	36. $E_I E_R$

* Indicates cases described in the text of the report.

MANAGING COMPANY CASH

by

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AN ABSTRACT OF A MASTER'S REPORT

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ABSTRACT

This report develops a logical framework for managing the cash of a firm. First cash management is put into its proper perspective. This proper perspective for cash management is the suboptimal goal of profit maximization. The overall goal of the firm is considered to be wealth maximization.

To obtain the suboptimal goal of profit maximization for cash management statistical techniques are used to estimate the variables that affect cash management. The application of multiple estimates in probability form is the basic approach used to achieve the "critical minimum" cash balance required to satisfy the suboptimal goal. This "critical minimum" cash balance determination is the end toward which the report strives to attain.

Statistical techniques are used for the determination of the most probable future levels and flows of inventories and receivables. Regression analysis is used to determine the past relationships of sales to inventories in the second section of the report. This past relationship is extended by extrapolation into the future. Then, to avoid single point estimates for the future relationship of inventories to sales, a probability distribution is formed using opinions of managers informed about the situation. This distribution is then superimposed upon the extrapolation of the regression line. The manager at this point has a multiple probability estimate, based both

upon the past trend and future expectations, for the level and flow of inventories.

The estimation for the future levels and flows of receivables is done in the same manner as for inventories. When the probability distribution has been superimposed upon the extrapolation of the regression line the manager may make multiple point estimates about the future relationships of receivables to sales.

These two predictions are put together to forecast when the firm will have excess or insufficient cash. The constraints imposed to modify this forecast are spelled out and briefly investigated. The problem of seeking funds, if the firm will have insufficient cash, is also briefly considered. Also the problem of investing excess cash is set forth and investigated.

Finally the total model of cash management is constructed in decision tree form. The previously determined probabilities associated with the many facets of the cash management problem are incorporated into this decision tree. By using these multiple point estimates the manager is able to predict with a defined degree of accuracy the "critical minimum" cash balance.