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The strategic determinants of working capital.

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THE STRATEGIC DETERMINANTS OF WORKING CAPITAL

A Dissertation Presented

By

KENNETH PRESSLEY NUNN, JR.

Submitted to the Graduate School of the University of
Massachusetts in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

September 1979

Business Administration

Kenneth Pressley Nunn, Jr.

1979

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To Claudia

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ABSTRACT

The Strategic Determinants of Working Capital

(September 1979)

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Directed by: Professor Ben Branch

As corporations grow larger and more diversified, the effective management of working capital at the product-line level becomes increasingly important. Deciding what inventory and receivables levels are appropriate for a given environment is an ongoing challenge both for product-line managers and corporate planners. With approximately 38% of the assets of manufacturing corporations tied up in working capital, the importance of effective working capital management is obvious. Yet, product-line managers and corporate planners do not have any set of tested integrated relationships to guide their strategic working capital decisions.

The major goal of this research has been to show the strategic relationships between working capital and its determinants, as well as the ongoing relationships between each component of working capital (i.e., accounts receivable, finished goods inventory, and raw material plus work-in-process inventory) and their respective determinants. Each resulting model was built using proprietary cross-sectional data from the Strategic Planning Institute's (SPI's) Profit Impact of Market Strategy (PIMS) data base. The PIMS data is product-line data, i.e., data at the appropriate level of aggregation.

The determinants of working capital and of its components were chosen through the utilization of the following four steps: (1) a priori hypotheses; (2) correlation analysis; (3) an exploratory factor analytic approach; and (4) interactions and curvilinear relationships derived in testing preliminary models. The four final models containing the determinants compiled in steps 1 through 4 above were tested by applying the PIMS four-year-average data base in a cross-sectional regression context. The working capital and component models were tested and found to explain a substantial portion of the variation in their respective dependent variables and to provide strong support for the vast majority of relationships hypothesized. In addition, the coefficients of each model were shown to be stable both across subsamples and across time periods.

The study yields many insights that should prove useful in managing working capital. Several are listed below:

1. The greater a business's level of media advertising, the lower its level of working capital.
2. The higher a business's prices relative to the competition, the greater its investment in accounts receivable.
3. The better a business's product image and company reputation relative to the competition, the lower its level of working capital.
4. The more capital intensive a business, the greater its level of working capital.

A knowledge of such determinants of working capital and its components should prove helpful to product-line managers and corporate planners in deciding which policies to pursue, for example, in evaluating acquisition candidates, making entry or exit decisions, forecasting long term needs, or judging the performance of existing management.

The final stage of the study involves examining the relationship between business's actual working capital and component levels (relative to their model's predicted values) and operating performance, as measured by Return on Investment (ROI). Empirical testing supported the existence of a strong inverse relationship between positive or negative deviations from the "normal" levels estimated by each model and ROI. These results indicate that the models have meaning from an operational point of view because failure to heed the signals given by the models generally leads to poor operating performance, i.e., to a lower ROI.

In summary, the process of building and testing models for working capital and its components has led to insights which are supported empirically, and should be useful to both corporate planners and product line managers in their efforts to improve operating performance.

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C H A P T E R I

INTRODUCTION

Background

During the 1970s the high rate of inflation and high cost of corporate funds have increased the importance of efficient asset management. An integral part of total assets is working capital, which is defined as the sum of the dollar value of three components: (1) accounts receivable, (2) finished goods inventory, and (3) raw material plus work-in-process inventory. According to recent Federal Trade Commission figures, U.S. manufacturing corporations have 38.4% of their total assets tied up in working capital (accounts receivable plus inventories) [35; p. 22]. Despite the magnitude of this investment, working capital management (interpreted here as the management of each component individually as well as the management of their sum) has taken a "back seat" up to now; thus, ". . . while major theoretical advances have been made in recent years with respect to the longer-range financial decisions of the firm, research devoted to shorter-range or working capital decision-making would appear to be less productive" [32; p. 50].

A business's working capital can be viewed as having two parts: one which fluctuates in response to short-run influences; the other which tends to remain fairly stable or "permanent" in the asset structure. While limited contributions have been made in aggregate analysis, marginal analysis, various programming techniques, and macro modeling, the focus of almost all research in the working capital area has been

short-run dynamic or tactical in nature. In contrast, the approach taken in this study is a strategic orientation which focuses on relationships thought to influence the product line's ongoing or "permanent" working capital needs. Although a tactical approach is useful in determining such matters as the economic order quantities and the amount of credit to extend to a particular customer, it is of little value in helping upper-level management and corporate planners answer strategic questions such as: What is the "normal" level of working capital for a given level of business? Or: Under given market and industry conditions, what variables determine this "normal" level?

As corporations have grown larger and more diversified, answering such strategic questions has become an increasingly important part of the corporate planning process. While the discussion which follows focuses on "working capital," it is equally applicable to the components of working capital: accounts receivable, finished goods inventory, and raw material plus work-in-process inventory; each of these components will be considered individually in the modeling process which is discussed in Chapter III. At this point, however, we shall consider some of the ways in which strategic questions arise.

Forecasting working capital requirements. In a diversified company, the usual practice is for business plans to be prepared by each product division or other operating unit. These plans are then reviewed by corporate executives, often with the assistance of staff specialists. Among the key elements of each unit's plan are estimates of working capital requirements for future periods. Often these forecasts are simply

projections of local experience. But when market conditions are expected to change, or when a change in strategy is contemplated, how reliable is the past as a guide to the future?

Allocating resources. A major purpose of reviewing divisional plans at the corporate level is to make effective allocations of capital, manpower, and other scarce resources among divisions. Often the working capital requests of the divisions add up to more than the corporate headquarters is willing or able to provide. Since divisional managers can be expected to plead their own case, corporate management needs to be able to assess the relative needs of component businesses operating in diverse environments.

Measurement of management performance. Closely related to the problem of forecasting working capital requirements is the need to evaluate the managerial performance implications of actual working capital levels. What is needed is some way of determining what level of working capital is reasonable or "normal" for different operating units functioning under given circumstances. Once determined, such a "normal" level could be compared with the actual level as one means of measuring the effectiveness of a manager's performance in the working capital area.

Appraising new business proposals. Yet another common problem in strategic planning is that of estimating the working capital requirements of a prospective new business which is being considered either for internal development or acquisition. When the business is new to the company, actual experience, by definition, cannot be consulted. Even when entry is

proposed via acquisition, the current working capital needs of the existing business may be of doubtful reliability as a guide to its future needs.

These four types of strategic planning situations highlight the need for understanding the major determinants of working capital in order to facilitate accurate estimation of appropriate working capital levels for a chosen business, under given industry and market conditions. Until recently, however, the major analytical data bases available to assist research in this area were historical industry averages and, within a given company, the past operating records of its own individual businesses. As a result of excessive aggregation, industry averages often obscure operating relationships relevant to a specific product line environment and ignore relationships involving product lines in other industries. The past operating results of an individual product line or even all of a company's own product lines would generally provide a myopic base for strategic decisions because the operating results represent one or a relatively small and potentially biased number of very limited sets of experiences; thus would provide little generalizable guidance when the strategic position of the business changes.

How can one explain variations in working capital from business to business in today's oligopolistic industries if dozens of factors are at work and only a handful of businesses compete in only one industry? One answer is to use a cross-sectional data base and to control for differences in working capital across industries and within industries.

This study takes such an approach using the Profit Impact of Market Strategy ("PIMS") data base, a proprietary cross-sectional data base containing the experiences of a relatively large number of businesses for a relatively long time period. This approach is put into practice through the use of a Par Working Capital model in a cross-sectional multiple regression context. Such a model is composed of determinants designed to explain why working capital varies from one business to the next, i.e., why some businesses have low working capital requirements and others very high ones. For example, a determinant such as relative product image helps explain why working capital requirements vary among competitors within an industry. Other determinants such as industry stability and industry exports help explain why working capital requirements differ across industries. Still other determinants such as order backlog and wage rate growth reflect both differences among competitors within the same industry and differences across industries.

In addition to providing estimates of the strategic working capital needs of individual business, the par modeling process leads to an improved understanding of relationships between working capital and its individual determinants, thus serving as a first step in building a much needed theoretical base.

Problem

Will an exploration of the relationships between working capital and the determinants of working capital which utilize the PIMS data base lead to insights that make possible more efficient working capital management ? Will a study of the relationships between the individual

components of working capital and their respective determinants lead to insights which make possible more efficient management of the individual components? Once built, will use of the models make possible more efficient management of working capital and its components? Clearly these are important questions. In order to deal with them effectively, however, it is important that certain key terms be carefully defined. In particular, the meaning must be explained of (1) the PIMS data base, (2) working capital and its components, and (3) determinants.

The PIMS data base. The PIMS program of the Strategic Planning Institute is a multi-company activity designed to provide an improved and innovative factual base for the business planning efforts of its participants. Each member company contributes information about its experiences in several business areas, i.e., in the majority of cases PIMS members are not one-product companies; in fact a substantial percentage are multi-product members of Fortune's 500, with many of the remainder in Fortune's second 500. The unit of observation in the PIMS data base is the "business." Each "business" is a division, product line, or other profit center within its parent company; each sells a distinct set of products and/or services to an identifiable group of customers, operates in competition with a well-defined set of competitors, and separates meaningfully its revenues, operating costs, investments, and strategic plans. Currently the data base includes 1200-plus businesses represented for varying number of years over the 1970-77 period. The information on each business is inputted by the participant company on a set of standardized forms designed to segment the required data items into simple elements

that can be readily assembled from financial or marketing records, or that can be estimated by someone familiar with the specific business.

The five major data forms [22] are labeled as follows:

Data Form 1	Description of the Business: Products and Services, Customers, Corporate Relationships
Data Form 2	Operating Results and Balance-Sheet Information
Data Form 3	Market and Competition
Data Form 4	SIC and Served-Market Data
Data Form 5	Assumptions for Strategy Analysis

A representative list [34] of the type of information inputted for each business is shown below.

Characteristics of the business environment.

- Long-run growth rate of the market
- Short-run growth of the market
- Availability and use of distributors
- Export/import balance of the industry
- Rate of inflation of selling price levels
- Rate of inflation of cost elements
- Number and size of intermediate customers
- Number and size of end users
- Purchase frequency and magnitude

Competitive position of the business.

- Share of the served market
- Share relative to largest competitors
- Product quality relative to competitors
- Prices relative to competitors
- Pay scales relative to competitors
- Marketing efforts relative to competitors
- Pattern of market segmentation
- Rate of new product introductions

Structure of the production process

- Capital intensity (degree of automation, etc.)
- Degree of vertical integration
- Capacity utilization
- Productivity of capital equipment
- Productivity of people
- Inventory levels

Discretionary budget allocations

- R & D budgets
- Advertising and promotion budgets
- Sales force expenditures

Strategic moves

- Patterns of change in the controllable elements above

Operating results

- Profitability results
- Cash flow results
- Growth results

The data base is proprietary and its use is restricted to PIMS member companies, PIMS staff member researchers and those authorized by PIMS to do research on the data base. As the representative list above indicates, the data base is broad in scope, going far beyond the aggregated balance sheet and income statement type data found in corporate annual reports. The most disaggregated corporate data available to the public is found in the SEC's 10-K reports which are filed annually by the nation's public corporations. The 10-K reports require "line of business" information. This includes information on each line of business for each of the past five fiscal years: the approximate amount of percentage of (1) total sales and revenues; and (2) income or loss before income taxes and extraordinary items; and if the line of business for either of the last two fiscal years constituted a major factor in the company's business operations [14].

The FTC [8] found that corporations were not reporting and do not report lines of business which correspond with product markets, but rather use very broad lines of business (sometimes as broad as "Consumer Products") which minimized the usefulness of the 10-K data for product-line research. Additionally, since each firm defines its lines of business, there is no consistent basis for working out comparisons between firms, making it virtually impossible to use the data to compare lines of business across reporting firms. Furthermore, while the nature of the changes in definition of "line of business" must be generally described in the 10-K, a firm is free, each reporting year, to reclassify various products from one line of business to another, thereby rendering incomparable its own product-line performance data.

Both because of the lack of comparability within and between firms and because of the lack of other relevant data--such as advertising expenditures, research and development expenditures and the like--the FTC in the early 1970s determined to compile its own "line of business" reporting program. The line-of-business program which the Federal Trade Commission is now in the process of instituting represents a substantial improvement in terms of data quality over the so-called line of business program at the SEC. In addition to the sales and revenue and income or loss data by "product-line," the FTC Form L-B calls for disclosure of such additional items as material costs, labor costs, gross margins, media advertising expenditures, other selling expenses, general administrative expenses, total assets, and various asset and capitalization data. All of this information is being collected by FTC-defined product categories which will be generally comparable from firm to firm. The FTC

effort to collect data from a number of firms has been hampered by litigation initiated by some of the firms from whom data was requested. The FTC data, while extensive, is not currently available for research by nonaffiliated academics [8].

Since the 10-K data base has the major weaknesses mentioned above, the only data base that is at all comparable to that of PIMS is the FTC data. The FTC's data base is, however, restricted to financial data while the PIMS data base also includes information on the business environment, competitive position, structure of the production process, and strategic moves for each product line. Thus the PIMS data base is a much richer source of information at the product line level than the FTC data base.

Working capital and its components. Working capital as used in this study is defined as the dollar value of net accounts receivable plus inventories, net of reserve for losses. The current liabilities--accounts payable, accrued wages payable, and accrued taxes payable--were not included in this study because as they exist presently in the PIMS data base, they are not suitable for research purposes.

For the majority of businesses in the PIMS data base, balance sheet components, such as cash, marketable securities, and short-term debt, are managed at the aggregated corporate level and not at the disaggregated business level. Thus the definition of working capital used in this study does not include the components for which corporate level management is responsible but concentrates instead on the working capital components that are under the direct control of business level management.

The focus of this study is, therefore, on working capital management as it relates to the business level decisions of multi-business corporations.

Determinants. Accepting the importance of managing working capital and its components effectively, what determines the appropriate dollar levels in the associated balance sheet accounts for a given business? Fitting models whose variables explain a substantial portion of the variation in working capital and its components is one of the major goals of this study. Such a model should provide much needed strategic guidelines for business level management.

Relevance of the Working Capital models to operating performance. Since this is a study of the strategic management of working capital, it is important that once the models are developed that they be further explored so as to ascertain whether or not they can help managers improve the operating performance of their businesses. Accordingly, the relationship between each model built and operating performance--as measured by return on investment (ROI)--will be tested using two different ROI models.

CHAPTER II

LITERATURE REVIEW

The major approaches to the study of working capital management can be divided into nine somewhat distinct groups [32]. The first three--aggregate guidelines, constraint set, and cost balancing--are partial equilibrium models; the next two approaches--probability models and portfolio theory--stress future uncertainty and historical interdependencies; while the last four approaches--mathematical programming, multiple goals, financial simulation, and econometric modeling--have a broader, more integrated focus.

In explaining some of the major approaches, use of symbolic notation will refer to the asset, liability, and equity components of the balance sheet. The following format and notation will be used to represent the balance sheet of a typical firm of business:

<u>Assets</u>	<u>Liabilities and equity</u>
Current assets, a_j	Current liabilities, ℓ_j
Fixed assets, A_j	Long term liabilities, L_j
	Equities, E_j

The balance sheet equation shows total assets, $\sum a_j + \sum A_j$, equaling total financial sources, $\sum \ell_j + \sum L_j + \sum E_j$. In general, "working capital" refers to the firm's current assets $\sum a_j$, whereas "net working capital" is given by $\sum a_j - \sum \ell_j$. The subscript j on each balance sheet category is used to indicate that there may be several specific accounts within each category, while the summation signs refer to totals within categories.

Aggregate Guidelines

The aggregate guidelines approach involves the use of general propositions or principles to guide management in formulating working capital policies. One variant [32; p. 51] of this approach centers on the use of short-term borrowing and lending to balance the available sources with contemplated needs:

$$b = (\sum a_j^* + \sum A_j - \sum \ell_j^*) - (\sum E_j + \sum L_j) \quad (1)$$

where $\sum a_j^*$ here excludes short-term marketable securities, and $\sum \ell_j^*$ excludes short-term bank borrowing. If net asset requirements (represented by the first bracketed term) exceed long term sources of financing (represented by the second bracketed term), then short-term bank borrowing is needed. If net asset requirements are less than long-term sources of financing, then excess funds should be invested in short-term marketable securities. An assumption of this approach is that a business firm would never hold short-term marketable securities while also incurring short-term debt. Applying this aggregate guideline approach in a marginal context, we see that current asset holdings should be expanded to the point where marginal returns on increases in those assets would just equal the cost of capital required to finance such increases and that current liabilities should be used in place of long-term debt whenever their use would lower the average cost of capital to the firm.

Walker [38; pp. 21-35] suggests several general propositions or guidelines as a first step in developing a theory of working capital:

- Proposition one: If the amount of working capital is varied relative to fixed capital, the amount of risk that a firm assumes is also varied and the opportunity for gain or loss is increased.
- Proposition two: The type of capital used to finance working capital directly affects the amount of risk that a firm assumes as well as the opportunity for gain or loss.
- Proposition three: The greater the disparity between the maturities of a firm's debt instruments and its flow of internally generated funds, the greater the risk, and vice versa.

In summary, Walker [38; pp. 34-35] draws attention to risk as the fundamental basis for a theory of working capital:

. . . in most cases, the opportunity for gain or loss varies directly with the amount of risk that management assumes. The theory briefly stated is that the policies governing the amount and type of working capital are determined by the amount of risk that management is prepared to assume. To illustrate, by increasing the amount of working capital required and thus increase the efficiency of capital [assuming that working capital has a higher turnover vis à vis sales than does fixed capital], resulting in an increase in total profits. Further, by employing more risk capital, management can increase the rate that is earned on equity capital; and finally management can employ more debt capital provided it can accurately determine the firm's ability to repay its obligations and schedule its maturity dates accordingly.

The strength of the aggregate guidelines approaches lies in their recognition of the joint characteristics of the working capital accounts, a recognition that makes aggregate analysis meaningful. Due to their generality, however, the aggregate guidelines approaches offer little help to financial managers in making and implementing specific working capital decisions. The generality of this approach is largely due to the assumption that if the optimal level of working capital itself is determined, the individual working capital accounts are necessarily optimized also. An alternative assumption is that the optimal level of each working capital account can be determined and then the individually optimized

sub-accounts can be assumed to determine the optimal level of working capital. Although this alternative assumption permits analysis of working capital decisions at a more relevant level of aggregation (i.e., the sub-account or component level), it requires, nevertheless, that the individual components of working capital be independent. This is an important qualification to bear in mind since a decision to expand inventories is not necessarily independent of the decisions necessary to manage receivables or cash. Nor is cash management always independent of receivables management. All contribute, in varying degrees, to the liquidity of the firm, and since liquidity affects earnings, they contribute to earnings as well. Thus the optimization of individual working capital accounts permits analysis at a more relevant level of aggregation, but ignores the interrelationships between working capital accounts.

Constraint Set

In this approach, working capital is viewed as a constraint set for the larger problem of minimizing cost or maximizing the value of the firm. Depending on the particular model being specified, the constraint set may take the general form of $f[\sum a_j]$ or $f[\sum a_j - \sum \ell_j]$.

Vernon Smith [33] proposes to minimize total production cost subject to money capital requirements, which includes both fixed assets and working capital. Working capital is defined as

$$\sum a_j - \sum \ell_j = \alpha S - \sum_i B_i W_i X_i, \quad (2)$$

where S is firm sales, X_i is the number of units of resource i used in

production, W_j is the unit price of that resource, and α and B_j are appropriate constants.

Vickers [37] also applies a net working capital constraint in his synthesis of production, investment, and finance:

$$\sum a_j - \sum x_j = q(Q) \quad (3)$$

where Q represents firm output. This constraint becomes part of the total money capital constraint, which is employed in the function maximizing the equity value of the firm.

These two excellent theoreticians acknowledge the importance of working capital in financial decision making. The usefulness of their approaches is, however, limited in that net working capital is treated as a single entity rather than as a series of interrelated accounts on both sides of the balance sheet.

Cost Balancing

The cost balancing approach can be represented as a minimization problem of the following type:

$$\underset{a_j}{\text{Minimize}} [c_1(a_j) + c_2(a_j) + \dots + c_n(a_j)] \quad (4)$$

where the decision variable is a particular current asset, a_j , and where $c_i(a_j)$ are distinct types of costs associated with the dollar level of that current asset. Typically, several cost components move in opposite directions as the level of a_j is varied. A representative listing of the three major types of costs associated with inventory investment is shown below:

Carrying costs

1. Cost of capital tied up
2. Storage costs
3. Insurance
4. Property taxes
5. Depreciation and obsolescence

Costs of running short

1. Loss of sales
2. Loss of customer goodwill
3. Disruption of production schedules

Shipping, receiving, and ordering costs

1. Cost of placing order, including production setup costs
2. Shipping and handling
3. Quantity discounts lost

The major types of costs shown above are used as inputs to a cost balancing model. In the case of inventory in the "economic order quantity" model, for example, $C_1(a_j)$ represents the shipping, receiving, and ordering costs associated with accumulating inventory, $C_2(a_j)$ comprises inventory carrying costs, and $C_3(a_j)$ denotes the costs of running short. The cost function shown in equation (4) is minimized and the economic order quantity or cost balancing order quantity is determined.

For accounts receivable, $C_1(a_j)$ might represent foregone profits as credit policy is relaxed and sales and receivables increase, while $C_2(a_j)$ could represent bad debt expenses and the opportunity costs of higher investments in receivables. In determining an appropriate cash balance, $C_1(a_j)$ would include order costs and brokerage fees for security investments, while $C_2(a_j)$ would reflect the opportunity costs of higher investment in cash balances.

The major limitation of cost balancing approaches is that they usually deal with only a single current asset, and do not consider interrelationships with other current assets and with current liabilities.

Probability Models

The three approaches for analyzing working capital presented above are deterministic. Probabilistic models generally deal with the same variables found above, except that certain of them are explicitly considered to be subject to random influences. For example, Beranek [4] extends some of his deterministic models for analyzing credit policy to include random rates of sales and random collection patterns. The inclusion of risk in working capital models necessitates a different type of objective function; for example, expected cost is expressed as $\sum_i P_i C_i(a_j, x_j)$ where P_i represents probability, while expected profit is expressed as $\sum_i P_i \Pi_i(a_j, x_j)$ where Π_i represents profitability. In each case, an expected value operation summarizes the uncertainty inherent in the cost and/or profit relationships. The forecaster could, for example, estimate the probability that sales will be high, average, or low. These subjective probabilities could be used to plot a rough distribution of possible sales levels, perhaps in the form of a bar chart. This distribution would provide the decision maker with significantly more information than would a point estimate. Thus through an explicit recognition of risk, more intelligent working capital decisions are possible.

Portfolio Theory

The main application of portfolio theory in finance has been to delineate risk-return relationships for portfolios of securities and for individual securities within portfolios. The vehicle for this delineation has been the Capital Asset Pricing Model (C.A.P.M.).

Cohn and Pringle [7] suggest that if the assumption of perfect financial markets was dropped and if market imperfections were introduced explicitly into the analysis of working capital, the C.A.P.M. would then be the appropriate vehicle for calculating the required rate of return on individual working capital accounts. The advantage of the C.A.P.M. approach is that it allows consideration of projects with greatly different levels of risks. Required rates of return are determined separately for each project, based on its systematic risk. This approach is particularly worthwhile in analyzing projects comprised heavily of receivables and/or inventories because these working capital components are generally less risky than fixed assets and would therefore require a significantly lower return than a project of average risk for a given firm.

The C.A.P.M. can be applied in analyzing individual working capital accounts except where there appear to be major violations of the perfect capital market assumptions. Thus if there are important imperfections, such as bankruptcy costs, rational investors would become concerned with both the systematic risk recognized by the C.A.P.M. and the unsystematic risk which is generally thought of as diversifiable. In general fewer imperfections would be expected in connection with a receivable's investment than with an inventory and/or fixed asset investment, and in certain cases fewer imperfections would be involved with an inventory investment than with a fixed-asset investment. Receivables are a financial asset rather than a real asset and, in general, fewer imperfections are evident in financial markets than in product markets. In contrast to receivables, inventories represent a real asset, just as fixed assets are real assets. Inventories are portable, however, and have other

characteristics that give rise to fewer imperfections. Thus fewer violations of perfect market assumptions are expected as one moves from less liquid to more liquid assets. The question is how should the imperfections that do exist be integrated into the C.A.P.M.? One possible solution is the employment of dual hurdle rates, i.e., one C.A.P.M. derived rate and one total risk derived rate, whereby a judgmental process decides which is more relevant for the specific current asset being analyzed. To date rare use is made of the C.A.P.M. for working capital decisions because the imperfections mentioned above have not been integrated into the theoretical model and because the general applicability of the C.A.P.M. is still questioned by many academicians and practitioners.

Mathematical Programming

Mathematical programming can concentrate on working capital directly and in a manner which deals simultaneously with a number of interrelationships. Several authors have discussed and illustrated programming approaches. Beranek [4] presents a series of models dealing with accounts receivable and cash balances. Robichek, Teichroew, and Jones [25] were the first to construct a linear programming model for the short-term financing of the firm under certainty. Their model is shown below:

$$\begin{aligned} &\text{Minimize } [\sum_k C_k(x_j)] \\ &\quad x_j \\ &\text{Subject to } f_1(x_j) \leq x_i^*. \end{aligned} \tag{5}$$

In this model the decision variables consist of different types of borrowing, namely x_j ; the objective function includes a number of relevant costs, represented by $C_k(x_k)$; and constraints, $f(x_j)$, place limits, x_i^* , on certain types of indebtedness. Mao [19] presents a partial reformulation of the above model in terms of stock variables, and Pogue and Bus-sard [23] reformulate the Robichek, Teichroew, and Jones model to allow explicit consideration of the uncertainty associated with forecasted cash requirements. An important feature of each of these linear programming models is that it requires explicit consideration of interrelationships between working capital accounts.

Multiple Goals

Another method for analyzing working capital involves the use of multiple goals in the objective function. Even though the usual programming approach includes a single goal, i.e., cost or profit, it is also possible to formulate the decision making problem as

$$\text{Maximize}_{b, \Pi} u[b(a_j, x_j), \Pi(a_j, x_j)], \quad (6)$$

where the preference function, u , summarizes management's feelings about the relative importance of liquidity, $b(a_j, x_j)$, and profitability, $\Pi(a_j, x_j)$ goals. The locus of feasible combinations of b and Π will depend on the nature of the firm, its investment opportunities, and its possible sources of financing. If the shape of u is specified, it may be possible to deduce the shape of indifference contours and the nature of specific solutions in profitability-liquidity space.

Krouse [16] suggests a multiple goal approach involving hierarchical optimization of a set of goals ranked in order of their relative importance to the firm. After the optimal level of the first goal is determined, a satisficing level for that goal is specified by management, and this level becomes a constraint for optimizing the second goal. The procedure is repeated with management able to see the trade-offs between various goals at each step. A second approach [20], on the other hand, views all the goals as "commensurable," which means that the goals are optimized simultaneously. Although such multiple goal approaches to working capital analysis may be difficult to implement in an operational sense, they probably come closer than many other alternatives to capturing the decision-making process actually employed by financial managers.

Financial Simulation

Financial simulation allows the analyst to incorporate both the uncertainty of the future and the many interrelationships between current assets, current liabilities, and other balance sheet accounts; and it also allows consideration of multiple goals, although the goals are neither specified in the objective function nor incorporated in an optimizing algorithm. The following example describes simulation applied to a single current asset or liability. Based on one thousand iterations of the financing requirements associated with normally distributed sales, a simulated frequency distribution of total interest cost, $\sum C_k(\ell_k)$, is generated for each of three financing strategies, i.e., for each of three different levels of current assets or current liabilities. Summary

measures from the simulated distributions of interest cost, such as mean or standard deviation, are then used to choose the desired strategy.

Proposing a simulation approach, Lerner [17] explains how cash budgeting can be extended to reflect the uncertainty inherent in future sales, the uncertainty in collecting accounts receivable, and the firm's flexibility in paying its accounts payable. By calculating both the mean and standard deviation of the distribution of forecasted cash balances, the decision-maker can simulate probable future outcomes. Similarly, Van Horne [36] proposes a probabilistic forecast of the cash flows of the firm as a way of making risk-return tradeoffs. He also suggests that different assumptions about sales, receivables, payables, and other related variables could be evaluated in terms of their effect on forecasted cash flows.

Warren and Shelton [39] present a model in which both current assets and current liabilities are directly related to firm sales. That is, $\sum a_j = f_1(S)$ and $\sum l_j = f_2(X)$ represent two out of a total of twenty simultaneous equations that are used to forecast future balance sheets of the firm, including $\hat{\sum a_j}$ and $\hat{\sum l_j}$. Although these forecasts are in aggregate, it would be possible to place separate emphasis on the working capital accounts within a larger simulation system. Thus by simulating future financial statements over a range of different assumptions, it would be possible to reflect uncertainty in forecasting future patterns of working capital. Obviously, the precision of the forecasts would depend on the accuracy of the specified relations underlying the simulation system.

Econometric Modeling

Recently econometric models have been introduced in the analysis of individual working capital accounts at the macro level. Yardeni [40] presents a portfolio-balance model of corporate working capital involving highly aggregated quarterly data. The model's weakness is in its predicting actual asset stocks in an out-of-sample simulation. The model's strength, on the other hand, lies in its explicit recognition that a decision to hold funds in a particular form is simultaneously a decision not to hold these funds in an alternative form. This portfolio-balance approach also advanced by Brainard and Tobin [5] and Smith and Brainard [31] acknowledges the essential interdependencies between working capital accounts through incorporation of adding up constraints.

The major problem with the portfolio-balance approach as acknowledged by Smith and Brainard [31] is that:

. . . it widens the already large gap between the number of parameters appearing in financial models and the number that can be reliably estimated from aggregate time series data. Indeed, it is undoubtedly the inadequacy of time series data which had led to the simplifications we find objectionable, and to the tireless search for the right combination of explanatory variables that will yield correctly signed and statistical significant coefficients.

It has seemed to us that an attractive alternative to the simplification of structure and deletion of variables is the use of 'a priori' information. In principle, this information could come from a variety of sources: theoretical calculation, cross-section studies, previous time series studies on different data, or even practical experience [31; p. 1299].

Thus a direct relationship exists between accurate, fully specified macro models and accurate information on the cross-sectional micro level. As a

result, precise estimation of priors could be aided greatly by accurate cross-sectional micro information.

Such information is sought in a study by Nadiri [21] of the determinants of trade credit in the U.S. total manufacturing sector. In his model, trade credit is considered as a selling expense like advertising outlays, and the opportunity or user cost of accounts receivable and accounts payable is specified. While Nadiri's study is macro in nature, his conclusion that user costs can be divided into three major elements-- (1) the carrying cost, (2) the depreciation cost, and (3) the lender's credit standard or the borrower's debt-repayment capacity--is potentially useful in the study of trade credit at the micro or product line level.

With a more specific focus in mind, a study by Herbst [12] attempts to find the determinants of trade credit in the U.S. Lumber and Wood Products Industry. In a two-step approach, he first examines simple, "passive" models for accounts receivable and accounts payable that contain a "generating" variable, a trend variable, and dummy variables which reflect seasonal influences. These initial efforts are directed at determining how well trade credit can be explained by the simple models $A/R = \emptyset$ (sales, trend, season) and $A/P = \psi$ (purchases, trend, season). The second step investigates models augmented by incorporation of macroeconomic variables, i.e., monetary variables and industry variables that seem "a priori" to influence trade credit for the industry. Herbst reaches the following tentative conclusions:

With receivables, it appears that the level is determined more or less automatically by sales, linear trend, and season of the year. In the case of payables, it seems that trend and season are unimportant and that the level of payables is determined instead by not only the level of purchases, but by capital requirements. Further,

the current obligation on bank term-loans plays an important role in determining the response of payables to the need for working capital [12; p. 392].

Herbst also finds that the direct influence of money supply and interest rates on accounts payable is not significant. The use of aggregate data for one industry is meant to shed light on relationships clouded by more aggregated data, but the extent to which counterbalancing effects between firms within the industry affect the results is not known and brings into question the applicable transfer of the results to individual firms within the industry.

In a continuation of the same study, Herbst [13] tests the relative endogeneity of trade credit, i.e., he attempts to find out if trade credit is determined by industry factors, macroeconomic factors or a combination of both. He regresses trade credit variables on industry and macroeconomic factors (found through factor analysis). He concludes that for the U.S. lumber and wood products industry, trade credit appears to be more closely related to industry than to national macroeconomic influences. These results are an important first step in determining the appropriate area of focus for future studies of trade credit.

In his study, Schwartz [30] develops a model in which trade credit, extended for longer than one month, is made an explicit part of selling price by discounting the selling price back to the present from the end of the credit period. It is believed that firms extending credit are selling a monetary resource and the model is viewed, therefore, as a vehicle for analyzing the effects of monetary policy on trade credit and vice versa. The model's explicit recognition of trade credit as part of selling price has yet to be treated empirically, but, if found true, the

accepted recognition would seem to have direct relevance to working capital management on the product-line level.

In their study, Schiff and Leiber [26] describe various inadequacies of many decision models for both accounts receivable and inventory management:

. . . Almost all of these models suffer from the following defects: they ignore the interrelationship between demand and both inventory policy and accounts receivable policy. In addition, they ignore the dynamic aspects of an accounts receivable policy as well as the interrelationship between inventory and accounts receivable policies. Inventory models are generally developed independently of receivable models and do not reflect the cost trade-offs and interaction between the two services [26; p. 133].

Based upon their model which recognizes the interrelationships between accounts receivable and inventory, Schiff and Lieber conclude that over time the fluctuations of the demand curve will cause changes in both inventory policy and credit terms. These changes are seen as smoothing the fluctuations in demand. The practical implication of this conclusion is that changes in credit terms should be considered when demand changes over time, i.e., seasonal changes in demand. These generalizations have yet to be tested empirically and are thus only a possible first step toward the integration of accounts receivable and inventory policies.

For his research purposes Beedles [2] works with a three equation simultaneous model to test the hypothesis that firms have multiple objectives, i.e., objectives in addition to stock price maximization. In making a comparison between the results of ordinary least squares versus two-stage least squares, he finds support for his hypothesis. In his exposition, Beedles notes the lack of attention that the modeling of corporations' structural equations has received relative to macro-modeling:

Since multiple equation structural models have rarely been used in empirical corporate finance research before, little agreement exists as to which variables are endogenous and which are exogenous. Further decisions concerning inclusion or exclusion of certain variables in a particular equation are not clear-cut [2; p. 1230].

Focusing on the lack of specification in the working capital area,

Beedles points out that

. . . [as] a practical matter, managers do not control a firm's investment in working capital as such. Rather, they determine, for example, receivables collection policies, which in turn influence the level of working capital. Thus, a more thorough specification [of the total model] would include a working capital equation [2; p. 1223].

In structural modeling, then, accurate specification of working capital relationships would help clarify the endogenous-exogenous and inclusion-exclusion problems referred to above.

Summary and Conclusion

The following table lists the major weakness of each approach to working capital management reviewed above:

<u>Approach</u>	<u>Major Weakness</u>
(1) Aggregate guidelines	Too general for practical application to working capital management
(2) Constraint set	Working capital is treated as a single entity rather than as a series of interrelated accounts
(3) Cost balancing	Usually focuses on one current asset, without considering interrelationships with other current asset and current liability accounts
(4) Probability models	Are applied to the above three approaches and therefore share their respective weaknesses
(5) Portfolio theory	Is difficult to implement due to working capital related imperfections which violate some C.A.P.M. assumptions

<u>Approach</u>	<u>Major Weakness</u>
(6) Mathematical programming	Lacks realism due to focus on one goal in the objective function
(7) Multiple goals	Appropriate specification of relationships involving working capital is difficult due to the lack of definitive empirical research in this area
(8) Financial simulation	Same weakness as (7) above
(9) Econometric modeling	Working capital relationships are studied at such a high level of aggregation that results cannot normally be generalized to the individual firm or product line level

The weaknesses listed in the summary table point to the need for an approach that will:

1. Reflect the interdependencies between working capital accounts
2. Employ data at a relevant level of aggregation
3. Allow the accurate specification of the major determinants of working capital as well as its components

In addition to the weaknesses listed above, the predominant focus of research in the working capital management area has been on the fluctuating portion of working capital, the portion thought to respond to short-run influences. Apparently, the reasoning behind this tactical focus is that working capital is composed of current assets which are generally expended within one year, and therefore should be analyzed primarily with an eye toward management's need to adjust in the short run. This short-run or tactical approach has either ignored or taken as given a business's ongoing or "permanent" investment in working capital. The present study, however, concentrates its attention on this "permanent" investment by analyzing the longer term or strategic impact on working capital of variables taken from the following dimensions:

1. Characteristics of the business environment
2. Competitive position of the business
3. Structure of the production process
4. Discretionary budget allocations
5. Strategic moves
6. Operating results

This approach, using information in each of the areas listed above, will help, it is hoped, to create a much needed strategic framework for longer term decisions involving working capital, and perhaps lead to more relevant tactical approaches too.

This study is designed to meet the needs advanced above by involving itself in the testing of hypotheses related to the determinants of working capital and its components in a strategic context, and by putting to work a unique business-level data base in a cross-sectional regression context.

CHAPTER III

MODELS

Introduction

The survey of the literature presented in the previous chapter clearly demonstrates the need for more research in the working capital area. Accordingly, this study will deal with two major projects designed to help fill the current void. First, models for working capital and its individual components (accounts receivable, finished goods inventory, and raw material plus work-in-process inventory) will be built and tested. Second, once these models are built, the relationship between each model and ROI (a measure of performance) will be examined. All of the empirical research will be based on analyses of the PIMS data base in a cross-sectional context. Table 3-1 below outlines the structure of the modeling process.

Table 3-1. The structure of the modeling process

<u>Model</u>	<u>Dependent Variable</u>	<u>Independent Variable(s)</u>
Working Capital	Working Capital/Revenue	Hypothesized Determinants
Accounts Receivable	Accounts Receivable/Revenue	Hypothesized Determinants
Finished Goods Inventory	Finished Goods Inventory/Revenue	Hypothesized Determinants
Raw Material plus Work-in-Process Inventory	Raw Material Plus Work-in-Process Inventory/Revenue	Hypothesized Determinants
Return on Investment	Return on Investment	Hypothesized Deviations for Each Dependent Variable

The general theory underlying each of the models described above is that micro-economic processes (working capital determination being one example) obey certain "laws of nature" that can be discovered through theorizing and empirical testing. The "laws of nature" or "laws of the marketplace" theory has been consistently supported by cross-sectional study of business-strategic experience using the PIMS data base [28]. One major conclusion derived from this ongoing set of cross-sectional studies is given below:

In making a strategic assessment of a business, it doesn't matter if the 'product' is chemical or electrical, edible or toxic, large or small, purple or yellow. What matters are the characteristics of the 'business'. . . . Two businesses making entirely different products, but having similar investment intensity, productivity, market positions, etc., will usually show similar operating results. And two businesses making the same products but differing in their investment intensity, etc., will generally show different operating results [29; pp. 6-7].

Thus cross-sectional approaches similar to the one taken in this study have been continuously validated in past research using the PIMS data base.

In the sections which follow, each model will be discussed individually by focusing on two major aspects:

1. The expected importance of the present research as an addition to currently employed asset management techniques, and
2. The reasoning behind the specific hypothesis being tested.

Working Capital

Introduction. As of September 30, 1978, 38.4% of the assets managed by U.S. manufacturing corporations were invested in working capital (defined as the sum of accounts receivable plus inventories)[35; p. 22].

As a practical matter, however, product line managers do not control the firm's investment in working capital. Rather the credit manager controls, or at least strongly influences this level of accounts receivable by adjusting the three credit policy variables: credit standards, credit terms, and collection policy. Similarly the inventory manager attempts to determine the level of inventories by deciding both the point at which to reorder and the size of each order. In both instances, however, customer reactions to the policies decided upon will also influence the actual levels of receivables and inventories. Moreover other nonspecific policies such as the amount of seller effort through advertising, the relative price charged, as well as the seller's guarantee and return policy will all have some influence on these working capital variables. Working capital emerges as a by-product of all of these various forces.

A relatively passive approach to managing working capital is necessitated by the dearth of practical models linking accounts receivable and inventories and incorporating their interrelated nature. The treatment of working capital as a passive residual derived by summing its individually optimized components is appropriate only if it can be assumed that the components are independent. The assumption of independence, however, is clearly not valid because in many instances a decision involving inventories is intimately related to decisions involving receivables. For example, suppose the inventory manager chooses to increase the business's holdings of finished goods at the request of the sales department, while noting that the increase in inventory is justified by the high cost of sales that would otherwise be lost due to

stockouts. In addition, suppose the credit manager chooses to lengthen the credit period, again at the request of the sales department, and justifies the move by contending that the added profits from additional sales are expected to exceed the added cost of receivables. The joint effect of inventory and receivables policy on customer service would not have been considered in an analysis of the separate components. In effect the enhanced profits from the additional sales would have been counted twice, resulting in an increase in customer service whose additional total cost could not be justified by the increased sales. This example has highlighted one of many situations in which the failure to recognize that inventory and accounts receivable decisions are interrelated can lead to inefficient use of working capital.

Thus if working capital is to be managed efficiently, i.e., expanded to the point where marginal returns on increases in working capital would just equal the marginal cost of the additional investment, an accurate understanding of the various relevant interrelationships is needed. To that end, the Par Working Capital model built in this study incorporates the interrelationships between working capital components and therefore can be used to estimate the appropriate "normal" or par level of working capital for a business operating under given market and industry conditions. If a model of this type is applied to the situation described in the previous example, the business's projected working capital level will be found to be in excess of its par level, signaling the need for corrective action.

The Par Working Capital model. The Par Working Capital model is used to test a number of hypotheses involving various factors such as brand loyalty, selling pressure, product demand, and supply which are thought to have an ongoing influence on the level of working capital. This strategic model was built in an effort to explain a substantial portion of the variation in working capital and is intended to help managers and planners determine the optimal level of working capital. The PIMS data base, used to test the model, describes the experience of a large number of businesses operating in diverse environments and the resulting model is, therefore, descriptive in nature and thus is not expected to predict the optimal level of working capital. Rather, the par model is an appropriate vehicle for answering strategic questions such as, what is the "normal" or par level of working capital for a given level of sales? Another question we might ask is, under given given market and industry conditions, what variables determine this "normal" level? A large number of the firms represented in the PIMS data base are multi-product members of the Fortune 500 list, therefore their working capital management techniques are expected to be relatively sophisticated, and the "normal" level estimated by the par model is expected to be a reasonably close approximation of the optimal.

The current research identified eight strategic factors thought to influence the level of working capital, and, consequently, relations were hypothesized for each:

1. Industry instability
2. Media induced brand loyalty
3. Reputation for service and quality
4. Selling pressure
5. Supply
6. Product demand
7. Wage rate growth
8. Industry exports

Table 3-2 describes the model in equation form and lists both the variable(s) used to test each hypothesis and the expected signs of each variable.

Working capital hypotheses. A brief discussion follows of each strategic factor and the hypothesis(es) related to it.

Industry instability. Businesses whose long-term industry sales instability has been high are expected to continue operating in an unstable market environment. The uncertainty of their market environments is expected to cause these businesses to carry relatively low levels of accounts receivable and finished goods inventory, and, in turn, a relatively low level of working capital.

Hypothesis 1: The greater the long-term variability of industry sales, the lower the level of working capital/revenue, but decreasing at a decreasing rate.

Media-induced brand loyalty. Media-induced customer loyalty to its brand name gives a business a competitive advantage by creating a captive market for its product(s). Businesses operating with this competitive advantage are less dependent on offering liberal credit terms or on having to make quick delivery to generate sales, and thus can be expected to carry lower levels of working capital than those businesses not having this advantage.

Table 3-2. Summary of the Par Working Capital model

Working capital model in equation form

$$Y_i = \alpha + b_1X_{i1} + b_2X_{i1}^2 + b_3X_{i2} + b_4X_{i3} + b_5X_{i3}^2 + b_6X_{i4} + b_7X_{i5} + b_8X_{i6} + b_9X_{i6}^2 + b_{10}X_{i7} + b_{11}X_{i8} + b_{12}X_{i9} + b_{13}X_{i10} + b_{14}X_{i11} + b_{15}X_{i11}^2$$

<u>Variable</u>	<u>Hypothesis</u>	<u>Expected sign of coefficient in model</u>	<u>Variable Name</u>	<u>PIMS variable #</u>
Y			Working capital/Revenue	N.A.
X ₁	1	negative	Industry instability	# 80
X ₁ ²	1	positive	Industry instability squared	# 80
X ₂	2	negative	Advertising media/Revenue	#157
X ₃	3	negative	Relative image	#330
X ₃ ²	3	positive	Relative image squared	#330
X ₄	4	positive	Sales force/Revenue	#147
X ₅	4	positive	Gross margin channels	# 38
X ₆	4	positive	Purchase frequency--immediate customers	# 27
X ₆ ²	4	positive	Purchase frequency--immediate customers squared	# 27
X ₇	5	negative	Purchases from components	# 43
X ₈	5	negative	Suppliers 3 largest	# 56
X ₉	6	negative	Order backlog	# 63
X ₁₀	7	positive	Wage rate growth	#338
X ₁₁	8	positive	Industry exports	# 83
X ₁₁ ²	8	negative	Industry exports squared	# 83

	<u>1970-73</u>	<u>1974-77</u>
Number of observations tested	568	198

See Appendix A for a technical discussion of the expected relationships.

Hypothesis 2: The greater media-induced brand loyalty, the lower the level of working capital needed to support a given level of sales.

Reputation for service and quality. The better a business's reputation for service and quality, the stronger its bargaining position vis-à-vis customers. Businesses in strong bargaining positions obviously possess the independence granted by competitive advantage. This leads to the expectation that they will carry lower levels of working capital than those businesses having weaker reputations for service and quality.

Hypothesis 3: The better a business's product image and company reputation, the lower the level of working capital needed to support a given level of sales, but decreasing at a decreasing rate.

Selling pressure. A business's sales force or channels of distribution do not normally have operating responsibility for accounts receivable or inventory. Salesmen (either internal or external) tend, therefore, to pressure the finance and production groups to extend relatively liberal credit terms to promote sales and to carry relatively high levels of inventory in order thereby to facilitate quicker delivery.

Hypothesis 4: The greater the selling pressure exerted internally by salesmen or externally by a business's channels of distribution, the greater the level of working capital needed to support a given level of sales.

Supply. The dependability of the source(s) of supply affects the magnitude of raw material buffer stocks necessary to insure continuous production and thereby impacts working capital levels. Businesses with dependable source(s) of supply are expected to have lower working capital levels because of their ability to economize on raw material buffer stocks.

Hypothesis 5: The more stable or dependable the source(s) of supply, the lower the level of working capital needed to support a given level of sales.

Product demand. The greater the demand for a business's product(s), the stronger its bargaining position vis-à-vis customers. The stronger a business's bargaining position the less the need to offer liberal credit terms or to make quick delivery in order to generate sales, and therefore, the lower the level of working capital needed.

Hypothesis 6: The greater the demand for a business's product(s), the lower the level of working capital needed to support a given level of sales.

Wage rate growth. The growth in wage rates paid by a business influences product cost which, in turn, affects work-in-process and finished goods levels. To the extent that price increases tend to lag wage increases, working capital/revenue can be expected to increase.

Hypothesis 7: The greater the growth of a business's wage rates, the greater the level of working capital needed to support a given level of sales.

Industry exports. Businesses in industries which export a substantial portion of their sales are also likely to be export-oriented. Businesses that depend upon exports for a substantial percentage of their sales can be expected to carry proportionately greater receivables due to complications in the billing process and also are likely to carry greater raw material and work-in-process transit inventories. These export-related effects can be expected to increase working capital levels.

Hypothesis 8: The greater the percentage of sales exported by a business's S.I.C. group, the higher the level of working capital/revenue, but increasing at a decreasing rate.

Accounts Receivable

Introduction. Accounts receivable represent the extension of open account credit by the firm to its customers. Since most business sales are made on credit terms, the investment in receivables represents a major and continuing commitment of funds. As of September 30, 1978, U.S. manufacturing corporations had 17.9% of their assets tied up in receivables [35; p. 22]. As used in this study, accounts receivable refers to gross accounts receivable less bad debt losses.

The Par Accounts Receivable model (discussed later in this section) is used to test a number of hypotheses involving factors thought to have an ongoing influence on the level of accounts receivable/revenue. An understanding of such strategic factors as price, market share instability, brand loyalty, relative product image, and capacity utilization is very desirable because credit policy is shaped by a business's operating characteristics viewed in the context of its market and industry environment. Since strategic considerations are implemented through changes in credit policy variables, the following segment will be devoted to an explanation of these variables.

Credit policy. Choosing the optimal credit policy involves taking account of the tradeoff between the profits on sales that give rise to receivables versus the direct costs that result from financing, bookkeeping, credit analysis, collections, and bad debt expenses. The policy

variables that are traditionally considered in this analysis include credit standards (quality of trade accounts accepted), credit terms (length of credit period, cash discount given, and any special terms given), and the collection policy of the firm. Once a business's strategic needs have been assessed, the various aspects to credit policy are implemented through the joint management of the relevant controllable variables. While this joint management largely determines a business's level of accounts receivable, exogenous factors such as customer reactions, monetary policy, and the state of the economy will also have an impact.

Credit standards. Credit policy can have a significant influence on sales. Clearly if a business's competitors extend credit more liberally than it does then its own conservative policy is likely to depress the marketing effort. Trade credit is one of many variables (price, product quality, service, etc.) that influence the demand for a firm's product. Consequently, the degree to which trade credit can promote demand depends upon what other factors are being employed. In general, the firm should set its quality standard for accounts accepted at the point that the profitability of sales generated equals the added costs of the receivables.

Credit terms. Credit terms involve both the length of the credit period and the discount given. The terms "2/10, net 30" mean that a 2 percent discount is given if the bill is paid before the tenth day after the date of invoice; payment is due by the thirtieth day and credit period is thirty days. Adjusting the length of credit period is another means

by which a firm may be able to affect product demand--hoping thereby to increase demand by extending the credit period or reduce financing costs by shortening the period. As before (see "Credit policy" section above), the tradeoff is between the profitability of additional sales and the required return on the additional investment in receivables.

Raising the discount can be expected to speed up the payment of receivables, whereas reducing the discount will have the opposite effect. To the extent that the discount is regarded as a means of price cutting, demand may be affected. In addition, bad debt losses may be reduced if the discount leads to an increased rate of payment from marginal credit risks. The financial manager must determine whether the benefits from speeding up collections, increasing demand, and reducing bad debt losses would more than offset the cost of an increase in the discount. If it would, the present discount policy should be changed. Alternatively a slower collection policy may be indicated under other sets of circumstances.

Another aspect of credit terms given to customers involves seasonal datings. During periods of slack sales firms will sometimes sell to customers while allowing some time to elapse before payment is due. These special terms granted are known as seasonal datings and may be employed to stimulate demand from customers who cannot pay until later in the season. Because datings can be tailored to the cash flow of the customer, they can play an important role in selling the goods. Again, we should compare the profitability of additional sales with the required

return on the additional investment in receivables to determine whether datings are an appropriate means for stimulating demand.

Collection policy. The overall collection policy of the firm is determined by the combination of collection procedures it undertakes. These procedures include such things as letters sent, phone calls, personal calls and legal action. One of the principal variables is the amount expended on collection procedures. Within a range, the greater the relative amount expended, the lower the proportion of bad debt losses and the shorter the average collection period. Sales are likely to be affected adversely, however, if the collection efforts of the firm become too intense and thereby result in unduly irritated customers. The appropriate level of collection expenditure again involves a tradeoff--this time between the level of expenditure and the value of possible lost sales on the one hand and the decrease in the cost of bad-debt losses and reduction in the investment in receivables on the other.

Summary. Thus it is clear that the credit and collection policies of a business involve decisions regarding (1) the quality of account accepted, (2) the credit period, (3) the cash discount given, (4) any special terms such as seasonal datings, and (5) the level of collection expenditures. In each case, the decision should take due account of what is to be gained by a change in policy as well as the cost of the change. Optimal credit policies, if achievable, would be those that resulted in the marginal gains equaling the marginal costs (assuming of course that second order conditions are also met).

As stressed earlier, credit policies are shaped by strategic factors such as price, market share instability, brand loyalty, relative product image, capacity utilization, etc. Thus the strategic factors, whose influence has not been examined at the business level, should be understood before attempting to optimize credit policy.

The Par Accounts Receivable model. The Par Accounts Receivable model is intended to help managers and planners determine the optimal level of accounts receivable. The current research identifies eleven strategic factors thought to influence credit policy. Relations are hypothesized for each:

1. Price effects
2. Market share instability
3. Gross margin
4. Selling pressure
5. Brand loyalty
6. Personalized customer relationships
7. Product demand
8. Industry instability
9. Industry exports
10. Process research and development
11. Capacity utilization

Table 3-3 describes the model in equation form and lists both the variable(s) used to test each hypothesis and the expected signs of each variable.

Accounts receivable hypotheses. A brief discussion of each strategic factor and the hypothesis(es) related to it follows.

Price effects. Businesses whose products are priced high relative to the competition or who forecast significant price increases, risk losing sales to lower priced competitors. Thus, by extending liberal credit terms and by maintaining a flexible collection policy, these

Table 3-3. Summary of the Par Accounts Receivable model

Accounts receivable model in equation form

$$Y = \alpha + b_1X_{i1} + b_2X_{i2} + b_3X_{i3} + b_4X_{i4} + b_5X_{i5} + b_6X_{i6} + b_7X_{i6}^2 + b_8X_{i7} + b_9X_{i8} \\ + b_{10}X_{i9} + b_{11}X_{i10} + b_{12}X_{i11} + b_{13}X_{i12} + b_{14}X_{i13} + b_{15}X_{i14} + b_{16}X_{i14}^2 + b_{17}X_{i15} \\ + b_{18}X_{i16} + b_{19}X_{i17} + e_i$$

<u>Variable</u>	<u>Hypothesis</u>	<u>Expected sign of coefficient in model</u>	<u>Variable Name</u>	<u>PIMS variable #</u>
Y			Accounts receivable/Revenue	#176
X ₁	1	positive	Relative price	#290
X ₂	1	positive	Percent change price short	#445
X ₃	2	positive	Your share instability	#374
X ₄	3	positive	Gross margin/Revenue	#157
X ₅	3	positive	Channels via retail	# 35
X ₆	3	positive	Industry concentration ratio	# 81
X ₆ ²	3	positive	Industry concentration ratio squared	# 81
X ₇	3	positive	Vertical integration backward	# 39
X ₈	4	positive	Sales force/Revenue	#147
X ₉	5	negative	Advertising + promotion/Revenue	#152
X ₁₀	6	positive	Standardization	# 9
X ₁₁	6	positive	Purchase frequency--immediate customers	# 27
X ₁₂	7	negative	Order backlog	# 63
X ₁₃	7	negative	Relative image	#330
X ₁₄	8	negative	Industry instability	# 80
X ₁₄ ²	8	positive	Industry instability squared	# 80
X ₁₅	9	positive	Industry exports	# 83
X ₁₆	10	negative	Process research + development/Revenue	#137
X ₁₇	11	positive	Capacity utilization	#236

	<u>1970-73</u>	<u>1974-77</u>
Number of observations tested	571	204

See Appendix A for a technical discussion of the expected relationships.

businesses may be able to decrease the risk of losing current or potential customers.

Hypothesis 1: The greater a business's selling price relative to the competition and/or the greater the forecasted increase in selling price, the greater the level of accounts receivable/revenue.

Market share instability. A fluctuating market share implies that a business is not in a strong position vis-à-vis competitors and that its market position needs strengthening. A business can extend more liberal credit through less vigorous enforcement of the net period, i.e., without changing its stated credit terms. Thus by extending more liberal credit, a business can strengthen its market position without prompting quick retaliation by competitors.

Hypothesis 2: The greater the actual or potential instability in a business's market share, the greater the level of accounts receivable/revenue.

Gross margin. A business's gross margin is a measure of the profitability of sales. Businesses with relatively high gross margins normally earn relatively high returns from marginal sales. These businesses can therefore profitably afford to set lower credit standards and accept relatively poorer credit risks because their high marginal returns will generally offset the increased bad debt losses from the higher marginal credit costs.

Hypothesis 3: The greater a business's gross margin, the greater the level of accounts receivable/revenue.

Selling pressure. A business's sales force does not normally have operating responsibility for accounts receivable, hence salesmen may well view credit as something approximating a free good. Consequently salesmen may put pressure on the credit manager to reduce credit

standards and to avoid customer alienation by pursuing collections less vigorously, thereby generating a relatively high level of accounts receivable.

Hypothesis 4: The greater the percent that sales force expenses are of sales, the greater the level of accounts receivable/revenue.

Brand loyalty. Media-induced customer loyalty to its brand name gives a business a competitive advantage by creating a captive market for its product(s). Businesses operating with this competitive advantage are less dependent on offering liberal credit to generate sales, and can therefore maintain relatively high credit standards, collect past due accounts more vigorously, and operate with a lower level of accounts receivable; a business functioning under such favorable conditions does not have to fear a loss of sales as much as it would if the loyalty of customers to its product was less pronounced.

Hypothesis 5: The greater the media-induced brand loyalty, the lower the level of accounts receivable/revenue.

Personalized customer relationships. Businesses whose product sales are heavily dependent on strong personal relationships with customers can be expected to shape their credit terms around individual customer needs and to be flexible in their enforcement of the net period.

Hypothesis 6: The more personalized a business's relationships with its customers, the greater will be the level of accounts receivable/revenue.

Product demand. The greater the demand for a business's product(s), the stronger its bargaining position vis-à-vis customers. Liberal credit should be granted only if its extension leads to profitable sales. Businesses in strong bargaining positions are expected to have

little to gain from relatively accommodating credit terms or from a flexible collection policy.

Hypothesis 7: The stronger the bargaining position of the seller, the less the need to use accounts receivable as a selling tool.

Industry instability. Businesses whose long-term industry sales variability has been substantial will expect to continue operating in an unstable market environment. These businesses are expected to be reluctant to extend liberal credit since operating in an unstable market environment increases the likelihood of both bad debts and cash flow problems.

Hypothesis 8: The greater the instability of long-term industry sales, the lower the level of accounts receivable/revenue, but decreasing at a decreasing rate.

Industry exports. Businesses in industries which export a substantial portion of their sales are likely to be export-oriented themselves. Businesses that do a large amount of exporting tend to have a higher level of receivables. Due to the added complication of customs requirements, insurance coverage, and guarantees of payment, they generally collect from foreign customers more slowly than from domestic customers.

Hypothesis 9: The greater the percentage of sales exported by a business's S.I.C. group, the greater the level of accounts receivable needed to support a given level of sales.

Process research and development. Relatively substantial expenditures on process research and development should often result in an improvement in relative product quality. In addition, the business will generally protect its process-related advances through patents. Having relatively high quality product(s) and process(es) which are protected by

patent, the business will be in a strong market position and thus will not need to use as liberal a credit policy to generate sales as might be necessary otherwise.

Hypothesis 10: The greater the percentage that process research and development expenditures are of sales, the lower the level of accounts receivable/revenue.

Capacity utilization. Businesses that want to utilize a relatively high proportion of their capacity need to sell relatively more of the finished product. Their need to sell greater quantities in order to attain higher capacity utilization is expected to lead to relatively accommodating credit terms and a flexible collection policy.

Hypothesis 11: The greater the level of capacity utilization, the higher the level of accounts receivable/revenue.

Inventory

Introduction. As of September 30, 1978, U.S. manufacturing corporations had 20.5% of their assets tied up in inventory [35; p. 22]. This major and continuing commitment of funds is divided between three major forms: raw material, work-in-process, and finished goods. Raw material inventories represent stocks of the basic material inputs into a company's production process. As material and labor are added to these inputs, they are transformed into work-in-process inventories. When completed and stocked they become finished goods inventories.

The functions of inventory. Regardless of their form (raw material, work-in-process, or finished goods), all inventories may be further described as performing one or more of the following functions: transit, cycle, buffer, anticipation, and decoupling.

The following description of the functions of inventory should prove useful in understanding how some of the strategic factors, analyzed later in this section, affect inventory levels.

1. Transit inventories. These are primarily pipeline inventories, arising because of the need to transport inventories from point A to point B in the production inventory system. Since this transit time is not instantaneous in most situations, significant quantities of transit inventories result.

2. Cycle inventories. These exist because of management's attempt to produce items in lot sizes, either economic order quantities or other reasonable lot sizes, rather than at exactly the rate they are used. In order to accommodate such a plan, inventories will tend to accumulate at certain points in the system.

3. Buffer. Inventories in this classification arise mainly from decisions regarding risk. The higher the service level the lower will be the risk of running out of stock and the greater are the required quantities in buffer inventories.

4. Anticipation inventories. These are the inventories that are built in anticipation of future demand. Anticipation inventory might take the form of a slack season inventory buildup designed to keep the work force stable while providing product to meet increased demand during the peak season. Inventory buildups to prepare for a vacation, to anticipate strikes, to anticipate price increases, and to provide initial inventories of new products and promotion items are also part of anticipation inventory.

5. Decoupling. Decoupling inventories separate dependent production centers. The independent operation of these centers may be achieved over a limited period of time by the use of decoupling inventories.

The approach to modeling inventory. In this study, models are built for both finished goods inventory and raw material plus work-in-process inventory. Raw material and work-in-process must be analyzed together in a single model because they are not reported separately in the PIMS data base. The use of a single model for raw material plus work-in-process, rather than two separate models, is not expected to detract greatly from the usefulness of the results because both inventory accounts are essentially production-oriented. The following general discussion of strategic factors and the analytical technique employed to determine optimal inventory levels is equally applicable to finished goods, work-in-process, and raw material inventory. Therefore "inventory," as used in this discussion, will stand for all three forms of inventory.

The par inventory models discussed later in this section are used to test a number of hypotheses involving factors thought to have an ongoing influence on the level of inventory needed to support a given amount of sales. An understanding of these strategic factors (standardization, capital intensity, competition, supply, etc.) is crucial because inventory levels are influenced by a business's operating characteristics viewed in the context of its market and industry environment. Since strategic considerations are implemented through changes in

inventory levels, the following segment will be devoted to an explanation of how inventory levels are determined.

Determining the optimal level of inventory. Theoretically, the optimal investment in inventory is that level which equates the marginal costs associated with inventory with the marginal benefits thereby derived. Some costs rise with larger inventories--included here would be warehousing costs, interest on funds tied up in inventories, insurance, obsolescence, depreciation, etc. Since these costs are, for the most part, associated with carrying inventories, they are designed as "carrying costs." Other costs decline if larger inventories are held--included here would be the opportunity cost of lost profits resulting from sales forfeited because of running out of stock; costs of production interruptions caused by inadequate raw material inventories; loss of customer goodwill; cost of not being able to take possible purchase discounts; and ordering costs, including setup costs for production runs, because larger inventories permit fewer orders to be placed. These declining costs, taken as a group, are designated as "ordering costs." Thus the inventory level that minimizes the sum of carrying costs plus ordering costs is the optimal level for a business.

The minimization technique described above can be expected to yield the optimal inventory level only if all carrying and ordering costs are included in the inventory total cost function. As stressed earlier, however, inventory levels are affected by such strategic factors as standardization, capital intensity, competition, and supply whose influence has not been examined on the business level. The

inventory total cost function must include the carrying and ordering cost implications of such strategic factors before an attempt is made to optimize inventory levels.

The Par Inventory models. The Par Finished Goods model and the Par Raw Material plus Work-in-Process model are intended to help managers and planners determine the optimal level of finished goods and raw material plus work-in-process inventory, respectively. Each model is described in the sections which follow.

The Par Finished Goods model. The current research identified eight strategic factors thought to influence finished goods inventory levels.

Relations were hypothesized for each:

1. Standardization
2. Capital intensity
3. Selling pressure
4. Brand loyalty
5. Non-price competition
6. Real sales growth
7. Industry instability
8. Development time for new products

A brief discussion of each strategic factor and the hypothesis(es) related to it, follows in the Hypotheses section.

Table 3-4 describes the model in equation form and lists both the variable(s) used to test each hypothesis and the expected signs of each variable.

Finished goods hypotheses. A brief discussion of each strategic factor and the hypothesis(es) related to it follows.

Standardization. Non-standard or made-to-order products are normally produced to the specifications of the individual customer. Thus

Table 3-4. Summary of the Par Finished Goods Inventory model

Finished goods inventory model in equation form

$$Y = \alpha + b_1X_{i1} + b_2X_{i1}^2 + b_3X_{i7} + b_4X_{i2} + b_5X_{i2}^2 + b_6X_{i3} + b_7X_{i3}^2 + b_8X_{i4} + b_9X_{i5} + b_{10}X_{i6} + b_{11}X_{i7} + b_{12}X_{i8} + b_{13}X_{i9} + b_{14}X_{i10} + b_{15}X_{i10}^2 + b_{16}X_{i11} + b_{17}X_{i11}^2 + e_i$$

<u>Variable</u>	<u>Hypothesis</u>	<u>Expected sign of coefficient in model</u>	<u>Variable Name</u>	<u>PIMS variable #</u>
Y			Finished goods inventory/Revenue	#181
X ₁	1	negative	Standardization	# 9
X ₁ *X ₇	1	negative	Standardization*Industry imports	#9*#84
X ₂	1	negative	End user = Manufacturers	# 14
X ₂ ²	1	positive	End user = Manufacturers squared	# 14
X ₃	2	positive	Gross book value/Revenue	#201
X ₃ *X ₈	2	positive	Gross book value/Revenue*Real sales growth	#201*#367
X ₄	3	positive	Sales force/Revenue	#147
X ₅	3	positive	Gross margin channels	# 38
X ₅ ²	3	negative	Gross margin channels squared	# 38
X ₆	4	negative	Advertising media/Revenue	#157
X ₇	5	positive	Suppliers integrated forward	# 59
X ₈	5	positive	Industry imports	# 84
X ₉	6	negative	Real sales growth	#367
X ₁₀	7	negative	Industry instability	# 80
X ₁₀ ²	7	positive	Industry instability squared	# 80
X ₁₁	8	negative	Development time new	# 12
X ₁₁ ²	8	positive	Development time new squared	# 12
Number of observations tested			1970-73 571	1974-77 204

See Appendix A for a technical discussion of the expected relationships.

upon completion, the product can be shipped immediately to the customer for whom it was built. In addition, businesses in import-oriented industries are expected to enjoy substantial economies in finished goods inventory if their products are made-to-order.

Hypothesis 1: The less standardized a product, i.e., the more made-to-order the product, the lower the level of finished goods buffer inventories carried to support a given level of sales.

Capital intensity. Businesses with capital intensive production processes have high fixed costs which act as an incentive for maintaining level production during periods of slack demand. Thus capital intensive businesses can be expected to carry additional amounts of finished goods cycle inventories during slack periods in order to maintain economies in production. Even capital intensive businesses with a high rate of real sales growth are expected to maintain relatively high levels of finished goods inventory.

Hypothesis 2: The more capital intensive the production process, the greater the level of finished goods inventory/revenue.

Selling pressure. A business's sales force or channels of distribution do not normally have operating responsibility for finished goods inventory. In order to avoid running out of stock, losing customer goodwill and possibly forfeiting sales, salesmen tend to pressure the production group to carry relatively large finished goods buffer stocks.

Hypothesis 3: The greater the extent to which sales pressure influences a business, the greater will be the level of finished goods inventory/revenue.

Brand loyalty. Media-induced customer loyalty to its brand name gives a business a competitive advantage by creating a captive market for its product. Businesses operating with this competitive advantage

are therefore less dependent on employing quick delivery as a selling tool, and will lose relatively few sales from stockouts. Thus, these businesses can carry a lower level of finished goods buffer stocks.

Hypothesis 4: The greater the degree of customer brand loyalty, the lower the level of finished goods inventory/revenue.

Non-price competition. If a business is competing with suppliers who have integrated forward or with foreign firms who can normally undersell domestic firms, then competing on price is not likely to be sensible. A possible alternative method of promoting customer goodwill is a policy of quick and dependable delivery, a potent form of non-price competition.

Hypothesis 5: The greater the competitive pressure in the form of suppliers integrated forward or in the form of imports, the greater the level of finished goods inventory/revenue.

Real sales growth. The product(s) of a business whose real sales growth is rapid are generally in great demand. High demand products are normally shipped upon completion, thereby minimizing the investment in finished goods buffer inventories.

Hypothesis 6: The greater a business's real sales growth, the lower the level of finished goods inventory/revenue.

Industry instability. The long-term variability of industry sales can be used to estimate a business's future sales variability. Businesses whose expected sales variability or instability is great can be expected to carry relatively low finished goods buffer stocks, thereby reducing the risk of being left with excess and/or obsolete finished goods inventory.

Hypothesis 7: The greater the instability of product demand, the lower the level of finished goods inventory/revenue, but decreasing at a decreasing rate.

Development time for new products. The time lag between the beginning of the development effort and new product introduction is normally relatively short for high demand, growth businesses, and significantly longer for mature, slow-growing businesses. Thus businesses with relatively long new product development times can expect to have a significantly smaller proportion of their sales contributed by new products. The smaller the proportion of sales contributed by new products production, the lower the level of finished goods inventory carried in anticipation of new product sales.

Hypothesis 8: The longer the time lag between the beginning of the development effort for a new product and market introduction, the lower the level of finished goods inventory/revenue, but decreasing at a decreasing rate.

The Par Raw Material plus Work-in-Process model. The current research identified nine strategic factors thought to influence raw material plus work-in-process inventory levels. Relations were hypothesized for each:

1. Supply
2. Standardization
3. New product production
4. Product line breadth
5. Capacity utilization
6. Competition
7. Selling pressure
8. Industry exports
9. Direct costs

A brief discussion of each strategic factor and the hypothesis(es) related to it follows in the Hypotheses section. Table 3-5 describes the model in equation form and lists both the variable(s) used to test each hypothesis and the expected signs of each variable.

Table 3-5. Summary of the Par Raw Material Plus Work-in-Process Inventory model

Raw material plus work-in-process inventory model in equation form

$$Y = \alpha + b_1X_{i1} + b_2X_{i2} + b_3X_{i3} + b_4X_{i4} + b_5X_{i5} + b_6X_{i6} + b_7X_{i7} + b_8X_{i7}^2 + b_9X_{i8} \\ + b_{10}X_{i9} + b_{11}X_{i10} + b_{12}X_{i11} + b_{13}X_{i12} + b_{14}X_{i13} + b_{15}X_{i14} + b_{16}X_{i15} + b_{17}X_{i16} \\ + e_i$$

<u>Variable</u>	<u>Hypothesis</u>	<u>Expected sign of coefficient in model</u>	<u>Variable Name</u>	<u>PIMS variable #</u>
Y			Raw material plus work-in-process inventory/Revenue	#186
X ₁	1	negative	Alternate sources of supply	# 58
X ₂	i	negative	Purchases from components	# 43
X ₃	1	negative	Suppliers 3 largest	# 56
X ₄	2	positive	Standardization	# 9
X ₅	2	positive	Purchase frequency--end users	# 26
X ₆	3	positive	Percent new products	#302
X ₇	4	positive	Breadth of product components	# 73
X ₇ ²	4	negative	Breadth of product components squared	# 73
X ₈	5	negative	Capacity utilization	#236
X ₉	6	negative	Number of competitors	# 69
X ₁₀	6	negative	Number of immediate customers = 50% sales	#348
X ₁₁	7	positive	Sales force/Revenue	#147
X ₁₂	7	positive	Sales to components	# 45
X ₁₃	7	negative	Relative image	#330
X ₁₄	8	positive	Industry exports	# 83
X ₁₅	9	positive	Purchases/Revenue	#102
X ₁₆	9	positive	Manufacturing + Depreciation/Revenue	#122
Number of observations tested			1970-73 571	1974-77 204

See Appendix A for a technical discussion of the expected relationships.

Raw material plus work-in-process hypotheses. A brief discussion of each strategic factor and the hypothesis(es) related to it follows.

Supply. The dependability of the source(s) of supply influences raw material levels by determining the magnitude of the buffer stock carried to insure continuous production. Businesses with dependable source(s) of supply will have a low risk of production interruptions caused by inadequate raw material buffer inventories, and will, therefore, be able to economize on the amount of these inventories held.

Hypothesis 1: The more stable or dependable the source(s) of supply, the lower the level of raw material inventory/revenue.

Standardization. Businesses producing non-standard products will have to procure more specialized and varied raw materials and perform a more complex set of production operations on them than those businesses producing standard products. The larger number of raw material buffer stocks and the added complexity of the production process leads to greater work-in-process decoupling inventories.

Hypothesis 2: The less standardized or the more "made to order" the product, the greater the level of raw material plus work-in-process inventory needed to support a given level of sales.

New product production. Production of new products leads to an investment in raw material and work-in-process inventory in advance of sales, i.e., during the introduction phase when channels of distribution are being stocked. The carrying of these anticipation inventories, needed to insure continuous production, increases the level of raw material plus work-in-process/revenue.

Hypothesis 3: The greater the degree of new product production, the greater the level of raw material plus work-in-process inventory/revenue.

Product line breadth. Businesses which produce a wide range of products relative to their competitors can be expected to procure more varied raw materials. The larger the number of individual parts that must be kept in inventory, the larger the raw material buffer stock that must be carried to avoid production interruptions.

Hypothesis 4: The greater the breadth of a business's product line, the greater the level of raw material/revenue, but increasing at an increasing rate.

Capacity utilization. Capacity and output can be enlarged by adding employees or increasing overtime, and neither addition need affect the level of work-in-process inventory. Thus by augmenting capacity, a business can generate greater output and sales without increasing the level of work-in-process decoupling inventories carried.

Hypothesis 5: The greater the degree of capacity utilized, the lower the level of work-in-process inventory/revenue.

Competition. The more competitive the market served by a business, then the smaller the difference between price and marginal cost, the lower the risk-adjusted rate of return, and the smaller the cash flow. Thus with greater competition comes additional pressure to minimize the cost of carrying raw material plus work-in-process inventory.

Hypothesis 6: The greater the competition in the market served by a business, the lower will be the level of raw material plus work-in-process inventory/revenue.

Selling pressure. To maintain customer goodwill a business responds to intense pressure by shipping its end product quickly and in adequate quantity; this pressure is transmitted via the business's sales

force, internal users, and by external sales channels. The greater the marketing pressure, the greater will be the level of raw material plus work-in-process buffer and decoupling stocks carried to insure product availability.

Hypothesis 7: The greater the pressure to ship the end product quickly and in adequate quantity, the greater the level of raw material plus work-in-process inventory/revenue.

Industry exports. Businesses in industries which export a substantial portion of their sales are likely also to be export-oriented. Businesses that depend upon exports for a substantial portion of their sales are likely to maintain part of their production operations in foreign countries; this situation causes the length of the inventory pipeline to increase, and with it the level of raw material plus work-in-process transit inventories carried to maintain continuous production.

Hypothesis 8: The greater the proportion of an industry's sales that is composed of exports, the greater will be the level of raw material plus work-in-process inventory/revenue.

Direct costs. A business's direct costs, i.e., the cost of materials, labor, and overhead needed to manufacture the end product, have an impact on raw material plus work-in-process inventory because it is normally valued at cost. Thus the greater the purchases component of cost of goods sold, the greater the level of raw material carried; and the greater the manufacturing labor plus overhead component, the greater the level of work-in-process inventory carried.

Hypothesis 9: Raw material plus work-in-process inventory/revenue varies directly with the proportion of total cost composed of purchases and manufacturing labor and overhead.

The Usefulness of the Par Models Developed

The models hypothesized above, for working capital/revenue and each of its components, hopefully explain a substantial portion of the variation in each dependent variable respectively. The normal or par values for working capital/revenue and its components could be generated by plugging the business's actual values for the independent variables into each model. If all businesses in the world were used to generate the model coefficients, the normal or par values generated for each dependent variable could be considered representative of the norm or par, given the characteristics of the business being studied. The PIMS data base is clearly not this extensive, but since it does cover a large segment of the domestic economy, it serves as a useful sampling of the behavior of businesses at the product line level. Thus using each respective model the calculated par values can appropriately be taken as an approximation of a business's normal steady-state level of working capital/revenue and its components under a particular set of conditions.

In all probability the theoretical par or theoretical normal value for working capital/revenue and for its components differs somewhat from that generated using the respective par models developed above. Considering the stability tests employed to check the validity of the models both during the 1970-73 time period and across the 1970-73 and 1974-77 time periods, and the relatively extensive coverage of the PIMS data base, however, the deviation from theoretical par is probably not large. Thus deviations from par can be viewed as signals that a business's current situation does not correspond to the norm and the

situation therefore merits further analysis. Often such signals will be indications of nonoptimal policies.

By way of clarification it should be noted that the par models are descriptive, not prescriptive models. Thus par is at best only an approximation of the optimal value. The par estimate for each dependent variable takes into account the business's own resources and strategic position and makes possible a more effective evaluation of managers. Moreover, an accurate estimate of a business's par level for each dependent variable can be very helpful in making planning decisions such as whether to expand or contract the level of working capital or the level of one or more of its components. In addition, a knowledge of how the environment and policies of a business affect the level of working capital and its components can be helpful in determining which policies to pursue.

As suggested, if a business's par level is a reasonable estimate of the theoretical normal level for each respective dependent variable, then deviations (positive or negative) of the business's actual level from the business's par level indicate that the actual level of the respective dependent variable is higher or lower than normal. Levels of working capital which are higher or lower than normal can have a major impact on a business's operating performance. Similarly, deviations for the components of working capital may be worth examining.

The Return on Investment Model

One way of showing that the working capital and component models have meaning from an operational point of view is to demonstrate that

failure to heed the signals given by the models will depress operating performance. Managers view ROI as a useful measure of operating performance [24; pp. 28 ff.]. Hence the relationship between ROI and deviation from par is used to measure the operating relevance of the models.

The relationship between ROI and deviation from par will be tested, individually, for working capital and each of its components. Use is made of two different models:

1. An abbreviated ROI model which relates ROI to deviation from par and a control variable (investment intensity), and
2. A full ROI model in which deviation from par is added to a thoroughly tested, proprietary par ROI model, currently in use [11; p. 14].

An abbreviated ROI model. The denominator of ROI contains working capital and the numerator is affected by working capital; therefore deviation from the par level for working capital/revenue or its respective components can be expected to have a significant impact on ROI. A recent study of ROI on the business level [11; p. 14] found in a multiple regression context that investment intensity (an index combining investment/revenue and investment/value added) explain a substantial portion of the variation in ROI. Accordingly, in testing the impact of working capital/revenue deviations from par and working capital/revenue component deviations from par on ROI, investment intensity will be included as an independent variable. The level of working capital/revenue or of its components is reflected in the investment intensity variable. Thus by including both investment intensity and working capital/revenue deviations from par or component deviations from par in the ROI model, it is

hoped that the effect of the level will be separated from the effect of deviation from par.

In order to permit the true relationship to reveal itself more fully, each deviation from par variable will be split into two parts--the negative deviation and the positive deviation--as will the investment intensity variable (discussed above). The multiple regression equation will take the form shown below for working capital/revenue deviation from par and/or component deviations from par:

$$\text{ROI} = \alpha + b_1 \cdot \text{INV INT}(-) + b_2 \cdot \text{INV INT}(+) + b_3 \cdot \text{DEV}(-) + b_4 \cdot \text{DEV}(+) + e_j$$

where INV INT (-) = negative values of normalized investment intensity

INV INT (+) = positive values of normalized investment intensity

DEV (-) = negative deviation from par

DEV (+) = positive deviation from par

The model was tested using data on 1140 businesses over the 1970-77 period. The deviation from par for working capital/revenue, accounts receivable/revenue, finished goods inventory/revenue, and raw material plus work-in-process inventory/revenue is expected to be negatively related to ROI in both the abbreviated model discussed above and in the full ROI model. To improve the flow of discussion, then, the full ROI model will be discussed next and followed by a formal statement of the hypothesis common to both models.

The Full ROI model. The PIMS Par ROI model [11; p. 14] is a regression model containing thirty-plus independent variables which consistently explain approximately 75% of the cross-sectional variation in ROI. The deviation from par for working capital and each of the component models

will be added individually to the PIMS Par ROI model to determine if their inclusion makes a substantial contribution to this already well-specified model. This test should be useful in determining the strength of the relationships represented by the deviation from par variables. The multiple regression equation will take the form shown below:

$$ROI_i = \alpha + \sum_{b=1}^i b_i [\text{each independent variable "i" in the PIMS Par ROI model}] + b_{i+1} * DEV(-) + b_{i+2} * DEV(+) + e_i$$

where DEV(-) = negative deviation from par

DEV(+) = positive deviation from par

A discussion of the independent variables in the PIMS Par ROI model appears in "The Par ROI Report: Explanation and Commentary on Report" by Gale, Heany, and Swire (see [11] for full reference). The full ROI model was tested using data on 1119 businesses over the 1970-77 period. The formal statement of the hypothesis common to both ROI models tested, as well as the reasoning relating ROI to each deviation from par variable, is discussed below.

Hypothesis* and reasoning.

Hypothesis 1: The greater the positive or negative deviation from par of working capital/revenue or of its components, the lower the ROI.**

*For the abbreviated model, no hypothesis is advanced for the relationship between negative and positive values of investment intensity because the study of this relationship is tangential to the study of working capital and its determinants. Thorough testing on the product-line level [29] has consistently supported a strong negative relationship between ROI and investment intensity. Thus while negative and positive values of investment intensity are incorporated in each model to control for the level of working capital/revenue or of its components, the discussion will focus on working capital/revenue deviations from par and its

As discussed earlier, par working capital and par components levels are thought to be approximations of a business's optimal level under given market and industry conditions. Analogously, deviations from par are expected to approximate deviations from the optimal, and to be associated with a lower ROI. For example, the greater the negative deviation from par working capital, the less is a business able to compete by extending adequate credit or by maintaining the stocks necessary to assure uninterrupted production, and the lower the expected ROI. Alternatively, the greater the business's positive deviation from par, the greater will be the unnecessary credit extended, or the poorer the collection policy, or the more excessive the investment in buffer inventories, and the lower the expected ROI. The relationship between ROI and deviation from par is tested, therefore, to measure the impact of strategic working capital policy on operating performance.

component deviations from par.

**Pre-tax net income, including special non-recurring costs, minus corporate overhead costs, as a percent of average investment including fixed and working capital at book value, but excluding corporate investment not particular to this business.

C H A P T E R I V

METHODOLOGY

The models --par working capital, par accounts receivable, par finished goods inventory, and par raw material plus work-in-process inventory--presented in the previous chapter were tested using the PIMS data base in a cross-sectional regression context. Since the data base contains over four hundred variables, several selection techniques (i.e., a priori theorizing, correlation analysis, and factor analysis) were employed in choosing the final set of variables for each model. In addition, the validity of each model was tested both across subsamples and across time periods, using analysis of covariance. The following subsections contain an expanded and detailed discussion of the process.

The Sample

The PIMS data base, described in some detail in Chapter I, was used in this study. The PIMS data base is a sample with data on over 1,200 businesses (product lines) from over 200 major corporations for varying numbers of years in the 1970-77 period. Since data on each of the 1,200-plus businesses was not in most cases available for all of the eight years covered, the specific year or combination of years chosen determined the number of businesses for which data was available.

Strengths. The PIMS data base is the most extensive available data base containing observations on the business unit or product-line level. Depending on the time periods chosen, it contains from one hundred to

eight hundred diverse businesses in its four-year-average data base. Moreover the data base is easily accessible to PIMS researchers via terminal hookup to its home computer at First Data Systems, and can be analyzed using a well-rounded, "canned" package of statistical tools designed specifically for the data base. These strengths combine to make the PIMS data base "the most comprehensive analysis system currently in use" [1; p. 610].

Weaknesses. The corporations which supply the data on some or all of their businesses are self-selected, thus the data base is not a random sample. Moreover there are many important corporations that do not supply data to PIMS and indeed the PIMS member corporations do not necessarily supply data on all their businesses; and since the type of data required by PIMS is confidential, when it is not supplied by the corporation, it is unavailable.

Self-selection in sampling [6] can lead to problems of representativeness. The potential lack of representativeness of the PIMS sample is recognized as a potential limitation on the generalizability of the results. It would appear, however, that the degree of systematic self-selection bias is reduced substantially by both the large size and the extensive diversity of the PIMS sample. Strictly speaking, results based on sample data are not generalizable beyond the members of the sample. Given the size and diversity of the PIMS sample, however, the likelihood is great that a large percentage of the businesses not represented in the PIMS sample compete in markets similar to those of the PIMS businesses, thus reducing the risk of inappropriate generalization.

As mentioned earlier, each business inputing data normally submits answers to approximately two hundred questions about its business. Many of the data items require estimates by the respondents who are usually members of the business's upper management. Since estimation is required, instrumentation [6] is a potential problem if significant variation in estimates was caused by differences between respondents. Under such circumstances, the estimates would vary due to the measuring instrument used, i.e., the respondent. This type of variation is assumed to affect the estimates in the PIMS sample, but since there is thought to be no reason for the variation to be biased in any particular direction, it is expected to be a random influence and therefore not to be a significant problem for this study.

Time period. The principal subjects of the PIMS data here were: two-year averages, four-year averages, six-year averages, or a year's average taken singly. Any periods of the above lengths could have been chosen between 1970 and 1977. Since this study was not concerned with temporary shorter term influences, but rather with ongoing relationships, the analysis of the one-year and two-year average data was not considered. Although use of the six-year average data set was given some consideration, the four-year average data set was ultimately selected for two reasons:

1. The four-year data base contained a significantly larger number of businesses than the six-year data base, and
2. With eight total years of data, the data base could be split into two contiguous four-year samples (i.e., 1970-73 and 1974-77). By building and testing each model using one four-year sample, the stability of coefficients could be tested by running each model on the remaining four-year sample. Since the focal point of this study

was ongoing relationships, a test of the stability of regression coefficients over time was crucial.

The Variable Selection Process

In selecting independent variables for the working capital and component models described in Chapter III, a substantial number of variables were assembled through a priori theorizing. Since very little previous empirical research exists in the area of strategic working capital management at the product-line level, an exploratory approach was employed as a guide to the selection of model variables. The two exploratory techniques chosen were: (1) correlation and (2) factor analysis.

Correlation analysis. The use of the four-year-average data base (SPI4) for the 1970-77 period provided a substantial number of potential independent variables from which to choose. From approximately 500 variables, 166 were selected which seemed related in some way to one or more of the dependent variables. After exclusion of missing values, the remaining sample contained 1684 observations on each of the 166 independent variables. The pairwise correlations for this variable group were examined to determine how each independent variable related to each dependent variable and how the independent variables related to each other. Relationships between variables were discovered, which proved useful in variable selection. Note, however, that pairwise correlation analysis, while useful as a screening technique, ignores multivariate relationships.

Factor analysis. Factor analysis [3,9,10,27], a multivariate technique, was chosen as a supplement to pairwise correlation analysis as a guide in variable screening. Factor analysis is a technique that permits reduction of the variable space under examination to a smaller number of factors. These factor patterns retain the maximum amount of information (explaining the maximum variance) contained in the original data matrix. The 166 selected variables avoided the working capital accounts and involved as little duplication as possible.

The AQD [27] factor analysis program, principal factoring, was used to recover the initial factors. The 43 canonical factors recovered were rotated employing a varimax rotation to simplify the factor pattern, thus making interpretation easier. The 43 orthogonal factors so derived represent 43 independent patterns of the 166 variables. The similarity of each variable to the factors in the reduced space was measured by its factor loading, which is simply the correlation of an original variable with a factor.

The next step was to use the forty-three factors in a regression context. Four regression models were built in which the dependent variables were working capital/revenue, accounts receivable/revenue, finished goods inventory/revenue, and raw material and work-in-process inventory/revenue, respectively; the independent variables were the forty-three orthogonal factors derived from the factor analysis. A regression was then run on each model. For each regression, the contribution of each factor to R^2 was examined and eight to ten key factors, i.e., those contributing more than 1 percent to explaining the variation of the dependent variable, were analyzed individually. For each model, variables

with high loadings on key factors (i.e., loadings $\geq .5$) were studied for possible insights into the processes influencing their respective dependent variable. Variables with high loadings on a given factor were screened and certain variables were chosen for possible inclusion in their respective model. To aid in interpretation each factor was given a name which seemed representative of its high loading variables. Appendix B contains a list of key factors for each model, along with their high loading variables and their respective contributions to R^2 .

Using factor analysis to view the original 166 variables in terms of key groups of variables (with each group making a different contribution) reinforced earlier a priori theorizing, yielded insights into the processes influencing dependent variables, and added clarity to the explanatory part of the variable selection process.

The Validation Process

Employing the variables selected for each model, the 1970-73, four-year-average (SPI4) data base was divided into two randomly selected subsamples: (1) the first subsample, containing 50% of the observations (i.e., businesses) and (2) the second subsample, containing the remaining 50%. Each model was built from the data in the first subsample and analysis of covariance was used to test the stability of regression results for each subsample and the combined subsamples.

The initial step in the validation process was to compare individual regression coefficients across the two subsamples. Individual coefficients were checked for differences in significance, changes in sign, and disparities in magnitude. If a substantial change existed in the

level of significance, or if a sign changed from being significant in one direction to being significant in the opposite direction and/or if a substantial change in magnitude occurred, then the logic of the related hypothesis was reexamined. This process concentrated on correcting specification problems involving interactions between variables, curvilinear relationships, and missing variables. The data in the first subsample was used in building the necessary respecifications into the model.

After rechecking and specifying new relationships as necessary, each model was validated using analysis of covariance [18; pp. 197-199]. The null hypothesis was that there is no significant difference between the set of regression coefficients generated employing each subsample. The null hypothesis was tested at a 5% level and supported for each model. The stability of each model across subsamples implied that while each model was built using observations from each respective first subsample, the relationships suggested by each model generally carried through to the second subsample, i.e., they were not subsample specific.

The next step in the validation process was to test the model built and validated on observations from the 1970-73 four-year-average data base, using observations from the 1974-77, four-year average data base. The models were tested for temporal stability applying analysis of covariance. The null hypothesis that there is no significant difference between the set of coefficients generated using the total 1974-77 sample was supported for each model at the 5% level. Their stability across time periods implied that while the models were built employing observations from each respective subsample, the relationships generally carried through to the second four-year time period, i.e., they were reasonably stable over time.

Testing

As stated above, each model was tested using multiple regression analysis. In the PIMS research data base observations greater than +4 or -4 standard deviations from the mean are given the value of +4 standard deviations if positive and the value of -4 standard deviations if negative. Data on each independent variable in each model was normalized prior to estimating the regression. Each dependent variable, in contrast, was kept in its non-normalized form. Thus regression coefficients were expressed in units of the dependent variable per standard deviation of the independent variable.

The regression results for each model, including the correlation of each independent variable with the dependent variable, the sign and t ratio of each coefficient, and each independent variable's contribution to R^2 are shown in Chapter V. Each time a model was tested on a given sample, two regressions were run, an initial regression on all observations in the sample, and a second regression on the observations that remained after dropping the extreme 2-1/2% observations in each tail of the distribution of residuals from the initial regression. This outlier deletion technique was used in order to eliminate the influence of extreme residuals which could have masked otherwise significant relationships of general importance. All analysis of covariance tests were performed using the results of initial regressions, i.e., before outlier deletion.

The Restriction of Working Capital/Revenue Coefficients

Since the sum of the components of working capital/revenue, i.e., accounts receivable/revenue, finished goods inventory/revenue, and raw material plus work-in-process inventory/revenue is by definition equal to working capital/revenue, prior information about the regression parameters of the working capital/revenue model is available. In light of this prior information if an independent variable is common to the three component models and the working capital/revenue model, its parameter in the working capital/revenue model should equal the sum of its parameters in each of the component models. Utilization of this prior information would impose a restriction on the working capital/revenue model that would reduce its generality. Kmenta [15; pp. 432-433] shows that utilization of prior information about a regression parameter in the estimation procedure yields a restricted least squares estimator that has a smaller variance than the ordinary unrestricted least squares estimator. Thus incorporation of prior knowledge improves the efficiency of the least squares estimators.

Unfortunately due to the large number of parameters utilized in each of the four models in this study, the iterative procedure necessary to minimize the joint sum of squared deviations of the four models could not be performed efficiently using the available computer capacity and statistical software. Therefore the prior information available has not been utilized in the estimation process. Rather the working capital/revenue model has been estimated without incorporating the knowledge contributed by each of the component models.

C H A P T E R V

RESULTS

The methodological approach described in Chapter IV was utilized to test the hypotheses discussed in Chapter III. The resulting empirical evidence supported the vast majority of relationships hypothesized--strategic relationships between the par models and their respective determinants. In addition, the par working capital and par component models were found to explain a substantial portion of the variation in each dependent variable (i.e., from a low of .203 to a high of .460). These positive test results were stable across subsamples as well as over time periods, implying that the relationships are strategic or ongoing, as hypothesized. Finally, the evidence points to the existence of a powerful relationship between strategic working capital decisions and operating performance, as measured by ROI. In the following sections, these results and the major insights gained from testing them are described in detail.

The Par Models

The par models for working capital and for its components were used to test a number of hypotheses. These hypotheses, involving strategic factors such as selling pressure, capital intensity, relative price, industry exports, etc., were discussed individually in Chapter III. The test results contained in Tables 5-1 through 5-4 provide evidence which is supportive of the relationships hypothesized in almost every instance. Each strategic factor tested is underlined and accompanied by its

Table 5-1. Regression Results: Par Working Capital Model

Hypothesis #	Variable	1970-73				1974-77		
		Correlation with Working Capital/Revenue	Expected Sign of Coefficient in Model	Sign of Coefficient in Model and t Ratio	Contribution to R ²	Correlation with Working Capital/Revenue	Sign of Coefficient in Model and t ratio	Contribution to R ²
1	Industry Instability							
	Industry Instability squared	-.072	-	-3.07	.012	-.153	-2.88	.027
		-.046	+	+2.56	.008	-.128	+2.09	.041
2	Media Induced Brand Loyalty							
	Advertising media expenses/revenue	-.154	-	-4.93	.031	-.114	-3.88	.049
3	Reputation for Service and Quality							
	Relative Image	-.161	-	-4.54	.026	-.131	-2.20	.016
	Relative Image squared	.125	+	+2.43	.008	.055	+.88	.003
4	Selling Pressure							
	Sales force expenses/revenue	.199	+	+5.16	.034	.167	+3.16	.033
	Gross margin to channels	.114	+	+3.35	.014	.177	+4.87	.078
5	Supply							
	Purchases from components	-.103	-	-3.43	.015	-.024	-1.01	.003
	Suppliers--3 largest	-.162	-	-4.08	.021	-.213	-2.02	.014
6	Product Demand							
	Order backlog	-.029	-	-1.83	.004	-.057	-.54	.001
7	Wage Rate Growth							
	Wage rate growth	.079	+	+2.12	.006	.125	+2.20	.016
8	Industry Exports							
	Industry exports	.214	+	+5.53	.039	.235	+.76	.002
	Industry exports squared	.074	-	-2.77	.010	.228	+1.50	.007
	Total R ² of Model				.278			.351

Table 5-2. Regression Results: Par Accounts Receivable Model

Hypothesis #	Variable	1970-73			1974-77		
		Correlation of Accounts Receivable/Revenue	Expected Sign of Coefficient in Model	Sign of Coefficient in Model and t Ratio	Correlation of Accounts Receivable/Revenue	Sign of Coefficient in Model and t Ratio	Contribution to R ²
1	<u>Price Effects</u> Relative price Percentage change in price--short term	.026	+	+1.50	.166	+4.04	.053
		.036	+	+ .86	.159	+3.45	.039
2	<u>Market Share Instability</u> Your share instability	.138	+	+3.77	.169	+3.82	.048
3	<u>Gross Margin</u> Gross margin/revenue Channels via retail Industry concentration ratio Industry concentration ratio squared Vertical integration-- backward	.016 .151 .095 .021 .027	+	+2.06 +3.83 +1.84 +1.46 +1.38	.116 .016 .042 -.107 .090	+1.45 + .99 +2.23 - .84 +2.29	.007 .003 .016 .002 .017
4	<u>Selling Pressure</u> Sales force/revenue	.132	+	+2.96	.147	+1.72	.010
5	<u>Brand Loyalty</u> Advertising + Promotion expense/Revenue	-.149	-	-5.31	-.115	-3.03	.030
6	<u>Personalized Customer Relationships</u> Standardization Purchase frequency-- immediate customers	.036 .183	+	+ .85 +3.77	.071 .072	+1.02 -1.01	.003 .003
7	<u>Product Demand</u> Order backlog Relative image	-.011 -.106	-	-1.15 -2.57	-.030 -.040	- .55 -4.04	.001 .053
8	<u>Industry Instability</u> Industry instability Industry instability squared	-.033 -.019	-	-1.84 +1.74	-.069 -.031	-2.50 +2.22	.020 .016
9	<u>Industry Exports</u> Industry exports	.146	+	+2.44	.196	+3.71	.045
10	<u>Process Research and Development</u> Process research and development/revenue	-.125	-	-3.73	-.057	-2.33	.018
11	<u>Capacity Utilization</u> Capacity utilization Total R ² of model	-.034	+	+1.92	.131	+1.38	.006 .368

Table 5-3. Regression Results: Par Finished Goods Inventory Model

Hypothesis #	Variable	1970-73				1974-77		
		Correlation of Finished Goods Inventory/Revenue	Expected Sign of Coefficient in Model	Sign of Coefficient in Model and t Ratio	Contribution to R ²	Correlation of Finished Goods Inventory/Revenue	Sign of Coefficient in Model and t Ratio	Contribution to R ²
1	Standardization	-.231	-	-5.09	.035	-.310	-5.57	.084
	End user = Manufacturer	-.156	-	-1.00	.001	-.183	-1.99	.011
	End user = Manufacturer squared	.087	+	+1.60	.004	.040	+.86	.002
	Standardization*Industry imports	-.082	-	-1.07	.002	-.077	-2.07	.012
2	Capital Intensity							
	Gross book value/revenue	.050	+	+2.09	.006	.255	+4.94	.066
	Gross book value/revenue* real sales growth	.057	+	+2.97	.012	.232	+2.91	.023
3	Selling Pressure							
	Sales force/revenue	.103	+	+3.72	.019	.053	+2.24	.014
	Gross margin to channels	.235	+	+3.52	.017	.271	+3.71	.037
	Gross margin to channels squared	.086	-	+.28	.000	-.048	-1.26	.004
4	Brand Loyalty							
	Advertising media/revenue	-.016	-	-2.60	.009	.001	-2.52	.017
5	Non-Price Competition							
	Suppliers Integrated forward	.101	+	+3.09	.013	.078	+.86	.002
6	Industry imports	.108	+	+1.66	.004	.125	+2.76	.021
	Real Sales Growth							
	Real sales growth	-.050	-	-3.24	.014	-.065	-1.43	.006
7	Industry Instability							
	Industry instability	-.076	-	-2.37	.008	-.139	-1.25	.004
	Industry instability squared	-.055	+	+2.08	.006	-.108	+.62	.001
8	Development Time--New Products							
	Development time--new	-.135	-	-4.78	.031	-.073	-2.04	.011
	Development time--new squared	-.011	+	+2.83	.011	-.105	+.07	.000
	Total R ² of Model				.228			.460

Table 5-4. Regression Results: Par Raw Material Plus Work-in-Process Inventory Model

Hypothesis #	Variable	1970-73				1974-77			
		Correlation of Raw Material Plus Work in Process Inventory/Revenue		Expected Sign of Coefficient in Model		Correlation of Raw Material Plus Work in Process Inventory/Revenue		Sign of Coefficient in Model and t Ratio	
									Contribution to R ²
1	Supply								
	Alternate sources of supply	-.064	-	-1.07	.001	-.125	-1.74	.010	
	Purchases from components	-.214	-	-6.30	.042	-.052	-.34	.000	
	Suppliers 3 largest	-.194	-	-6.06	.039	-.246	-3.98	.052	
2	Standardization								
	Standardization	.138	+	+1.72	.003	.163	+1.88	.011	
	Purchase frequency--end users	.291	+	+5.82	.036	.108	+1.27	.005	
3	New Product Production								
	Percentage new products	.149	+	+2.19	.005	.109	+1.59	.008	
4	Product Line Breadth								
	Breadth of product components	-.029	+	+1.34	.002	-.087	+.40	.001	
	Breadth of product components squared	.108	+	+2.70	.008	.084	+1.83	.011	
5	Capacity Utilization								
	Capacity utilization	-.148	-	-1.70	.003	-.204	-3.08	.031	
6	Competition								
	Number of competitors	.006	-	-1.23	.002	-.043	-.83	.002	
	Number of immediate customers = 50% sales	-.115	-	-2.43	.006	-.183	-2.42	.019	
7	Selling Pressure								
	Sales force/revenue	.158	+	+4.40	.021	.087	+2.27	.017	
	Sales force to components	.135	+	+2.47	.007	.139	+2.45	.019	
	Relative image	-.099	-	-3.19	.011	-.128	-1.52	.007	
8	Industry Exports								
	Industry exports	.223	+	+6.16	.040	.255	+3.68	.044	
9	Direct Costs								
	Purchases/Revenue	-.023	+	+3.81	.016	-.021	+2.11	.014	
	Manufacturing + Depreciation/Revenue	.180	+	+6.10	.040	.111	+1.25	.005	
	Total R ² of Model				.389			.339	

hypothesis number. In addition, the tables show each variable's name, its simple correlation with the dependent variable, its t-ratio in the equation, and its contribution to R^2 (the amount by which the R^2 would decline if the variable were deleted from the equation while all other variables were retained).

While a brief discussion of the results of testing each model's individual hypotheses can be found in Appendix C, the major insights gained from running these regressions are described below.

Sales pressure. The evidence supports a positive relationship between the level of working capital/revenue (and of its components) and the influence of the sales force within a business and the channels of distribution outside a business. Sales pressure was measured using sales force expense/revenue, gross margin to channels, and the purchase frequency of immediate customers. Working capital levels are increased when quick delivery and liberal credit are employed to stimulate sales; therefore quick delivery and liberal credit should be considered explicitly in making working capital decisions. Since quick delivery and liberal credit are not "free goods," the sales force and channels of distribution should be held accountable for their influence on working capital levels. The positive benefits of increased sales should be measured against the costs of increasing those sales--particularly the costs of increasing working capital.

Relative product image and company reputation. The findings suggest that a business's relative product image and company reputation as perceived by end users is negatively related to working capital/revenue, as well as

being negatively related to its components', accounts receivable/revenue and raw material plus work-in-process inventory/revenue. Thus the evidence supports the existence of a tradeoff between a business's relative image and the level of working capital needed. If a business has a poor relative image, it is more likely to compete by providing a readily available product and liberal credit terms, whereas if it has a favorable relative image, it can compete with a lower level of working capital and rely on its product image and company reputation to keep customers satisfied.

Capacity utilization. The results also point to a positive relationship between a business's level of capacity utilization and accounts receivable/revenue; on the other hand, a negative relationship exists between level of capacity utilization and raw material plus work-in-process inventory/revenue. Thus a business should take account of this tradeoff in determining the economic level of capacity to utilize. The greater the capacity utilized, the greater the credit extended as a means of attracting the necessary sales, but the lower the level of work-in-process inventory needed due to the economies of generating greater output from the same level of work-in-process inventory.

Standardization. The extent to which a business's products are made to order was found to be positively related to raw material plus work-in-process inventory/revenue and negatively related to finished goods inventory/revenue. The more made to order or the less standardized the product, the more complex the material requirements and production process, increasing raw material plus work-in-process inventory/revenue,

but the greater the possibility that the product can be shipped upon completion, decreasing finished goods inventory/revenue. Thus a business should take account of this tradeoff in such matters as making acquisition decisions, expanding into new product areas, and in setting inventory guidelines for established products.

Stability and dependability of the sources of supply. The evidence indicates that an inverse relationship exists between the level of working capital/revenue and the stability and dependability of the source(s) of supply. In addition, an inverse relationship exists between the level of raw material plus work-in-process inventory/revenue and the stability and dependability of supply. Supply considerations like the extent to which (1) alternate sources are available, (2) material is purchased from components, or (3) material is purchased from a business's three largest suppliers, indicate the degree of stability and dependability of the source(s) of supply. The greater the stability or dependability of the source of supply, the lower the level of raw material buffer stocks needed to maintain continuous production. Thus the stability and dependability of the source(s) of supply should be considered explicitly in choosing the appropriate level of raw material inventory.

Relative price. The findings point to a positive relationship between the level of accounts receivable/revenue and a business's relative price. This relationship supports Schwartz's hypothesis in which trade credit is viewed as part of the selling price [30]. The greater a business's selling price relative to that of its competitors, the greater the need to use generous credit as a means of attracting new customers and

retaining current customers. Thus businesses which are contemplating raising prices relative to those charged by competitors should expect to use some of the funds generated by the price increase to finance a higher level of accounts receivable/revenue.

Market share instability. Another positive relationship was found to exist between the level of accounts receivable/revenue and the degree of instability in a business's market share. The greater the instability of market share, the less certain a business can be that current customers will remain loyal or that potential customers will choose its products. Thus managers and corporate planners should recognize the link between market share instability and the level of accounts receivable/revenue in setting guidelines at the business level.

Real sales growth. A negative relationship prevailed between the level of finished goods inventory/revenue and a business's real sales growth. The greater a business's real sales growth, the greater the demand for its products, the less the buildup of finished products in inventory, and the lower the level of finished goods inventory needed. Thus managers and corporate planners should consider the relationship between finished goods inventory/revenue and a business's real sales growth in setting operating guidelines and in calculating future funds needs.

Industry imports. The evidence implies that the level of finished goods inventory/revenue is positively related to the level of imports in a business's Standard Industrial Classification group. Domestic businesses have a potential advantage over foreign businesses competing in their

served market--they should be able to ship more quickly, more dependably, and at lower cost due to geographic considerations alone. Thus the greater the competition from imports, the greater the need for domestic businesses to counter the competition with quick and dependable shipments, and the greater the level of finished goods buffer stocks needed. Recognition of the relationship between industry imports and finished goods inventory is necessary in setting operating guidelines at the business unit level.

Competition. The findings indicate that the level of raw material plus work-in-process inventory/revenue is negatively related to the degree of competition in a business's served market, as measured by the number of competitors in the served market and the number of customers that contribute 50% of sales. The greater the degree of competition in a business's served market, the smaller the return on investment (risk constant), and the greater the need to economize on raw material and work-in-process buffer stocks in order to maintain a "normal" rate of return. This finding supports the public policy position: Competition promotes more efficient use of resources.

Media-induced brand loyalty. Another negative relationship was found to exist between the level of working capital/revenue and the degree of media-induced brand loyalty, as measured by advertising expense/revenue and advertising plus promotion expense/revenue. Media-induced brand loyalty gives a business a competitive edge by creating a captive market, i.e., those customers who will buy only its brand. Thus the greater the media-induced brand loyalty, the less the need to use quick delivery

or liberal credit as selling tools and the lower the levels of both finished goods inventory and accounts receivable. An awareness of this tradeoff should prove useful to managers and planners in analyzing the benefits of customer loyalty to their brand.

Capital intensity. The evidence supports a positive relationship between the level of finished goods inventory/revenue and capital intensity, as measured by a business's gross book value/revenue. The more capital intensive the production process, the greater the level of finished goods inventory needed to insure an efficient balance between utilization of capital and product demand. An understanding of this strategic relationship should prove useful in analyzing finished goods levels both among competitors and across industries.

Industry exports. Similarly, the results indicate that a positive relationship exists between the level of working capital/revenue and the percentage of sales exported by a business's Standard Industrial Classification group. The greater the level of industry exports, the greater the possibility that businesses in the industry maintain part of their production operations in foreign countries in order to reap cost savings. This overseas production lengthens the supply pipeline, thereby increasing raw material and work-in-process inventory levels. In addition, trade with foreign countries requires a longer billing process and therefore a higher level of accounts receivable. These results suggest that businesses in export-oriented industries should expect to carry relatively high levels of working capital.

Industry instability. The level of working capital/revenue was found to be negatively related to the degree of industry sales instability. The greater the instability in an industry's sales over the long term, the less predictable is product demand, and the greater is the potential for cash flow problems. The uncertainty of product demand leads to lower levels of finished goods due to the risk of being left with excess and/or obsolete stock. The greater potential for cash flow problems acts to discourage the business from extending liberal credit.

The Variation Explained

Each par working capital and par component model explains a substantial portion of the variation in its dependent variable. The percentage of the variation explained by each model is shown in Table 5-5. These results demonstrate that the par models may be useful in determining the "normal" level for working capital and for its components.

Table 5-5. Variation explained by each model

<u>Dependent Variable</u>	<u>Variation Explained</u>	
	<u>1970-73</u>	<u>1974-77</u>
Working capital/Revenue	.278	.351
Accounts receivable/Revenue	.203	.368
Finished goods inventory/Revenue	.228	.460
Raw material plus work-in-process inventory/Revenue	.389	.339

Moreover, to the extent that the normal values can be taken as proxies for the optimal levels, use of such models could help managers improve their: (1) forecasts of the needed working capital or component levels, (2) allocation of corporate resources, (3) measurement of management performance, or (4) appraisal of policy proposals.

The factors responsible for the unexplained variation in each par model cannot be known with certainty. It is thought, however, that each of the following, largely uncontrollable factors, contributes to some extent:

1. Measurement error
2. Excluded variables
3. Differing costs of capital between firms
4. Mistakes made by businesses

These factors will be discussed in more detail in Chapter VI.

Before proceeding to the next section, a technical clarification related to Tables 5-1 through 5-4 will be discussed. The results of testing each of the par models indicate that the sum of the incremental contributions to R^2 are not equal to the total R^2 of the model. This follows from the fact that a variable's incremental contribution to R^2 reflects its multivariate relation with all of the other variables' effects previously considered. In other words, a variable's incremental contribution is in fact the amount by which the equation's R^2 would decline if that specific variable were deleted with the other variables retained. Therefore, given that the independent variables in the model are correlated to a small degree, dropping a variable changes the variation explained by an amount which reflects not only the variable's univariate influence but also its effect in combination with other variables in the model.

Analysis of Covariance Tests

For each of the preceding models, two analysis of covariance tests were run, one comparing the model coefficients across subsamples with those for the combined subsamples, and the other comparing the model coefficients for the two separate time periods with those for the combined sample. None of these tests revealed significant differences either across subsamples or across time periods (at the 5% level) indicating that for each working capital model, i.e., working capital/revenue, accounts receivable/revenue, finished goods inventory/revenue and raw material plus work-in-process inventory/revenue, the stability of coefficients was supported across the two subsamples from the 1970-73 period and across the two time periods, i.e., across the 1970-73 sample and the 1974-77 sample. These results are summarized in Table 5-6.

The Return on Investment Models

The abbreviated ROI model. The results of testing Hypothesis 1 (i.e., the greater the positive or negative deviation from par of working capital/revenue or of its components, the lower the ROI), are shown in Table 5-7. Both linear and curvilinear relationships were tested for each deviation from par variable. The conclusions reached in testing the linear relationships are consistent with those reached in testing the curvilinear relationships.

Insights and implications. The results of testing the abbreviated ROI model strongly support the hypothesis that the greater the positive or negative deviation from par of working capital/revenue or of its

Table 5-6. Analysis of covariance tests

Working Capital/Revenue

Test across subsamples (1970-73)

$$F_{15,598} = 1.62 \quad F_{\text{critical}} = F_{.05,15,598} = 1.67 \quad \therefore \text{N.S.}$$

Test across time periods (1970-73 and 1974-77)

$$F_{15,823} = 1.36 \quad F_{\text{critical}} = F_{.05,15,823} = 1.65 \quad \therefore \text{N.S.}$$

Accounts Receivable/Revenue

Test across subsamples (1970-73)

$$F_{19,594} = 1.15 \quad F_{\text{critical}} = F_{.05,19,594} = 1.60 \quad \therefore \text{N.S.}$$

Test across time periods (1970-73 and 1974-77)

$$F_{19,819} = 1.31 \quad F_{\text{critical}} = F_{.05,19,594} = 1.58 \quad \therefore \text{N.S.}$$

Finished Goods Inventory/Revenue

Test across subsamples (1970-73)

$$F_{17,596} = 1.24 \quad F_{\text{critical}} = F_{.05,17,596} = 1.67 \quad \therefore \text{N.S.}$$

Test across time periods (1970-73 and 1974-77)

$$F_{17,836} = 1.48 \quad F_{\text{critical}} = F_{.05,17,837} = 1.65 \quad \therefore \text{N.S.}$$

Raw Material Plus Work-in-Process Inventory/Revenue

Test across subsamples (1970-73)

$$F_{17,603} = .81 \quad F_{\text{critical}} = F_{.05,17,603} = 1.67 \quad \therefore \text{N.S.}$$

Test across time periods (1970-73 and 1974-77)

$$F_{17,836} = 1.48 \quad F_{\text{critical}} = F_{.05,17,837} = 1.65 \quad \therefore \text{N.S.}$$

Table 5-7. Regression Results: Abbreviated ROI Model

	<u>Correlation with ROI</u>	<u>Expected sign of coefficient in model</u>	<u>Sign of coefficient in model and t ratio</u>	<u>Contri- bution to R²</u>
<u>Regression 1</u>				
Investment intensity negative	-.413	-	-15.50	.149
Investment intensity positive	-.307	-	- 3.73	.009
Working capital/revenue negative deviation	-.176	+	+ 1.68	.002
Working capital/revenue positive deviation	-.223	-	- 2.74	.005
<u>Regression 2</u>				
Investment intensity negative	-.403	-	-16.30	.166
Investment intensity positive	-.307	-	- 4.64	.014
Accounts receivable/revenue negative deviation	-.051	+	+ 3.42	.007
Accounts receivable/revenue positive deviation	-.139	-	- 1.73	.002
<u>Regression 3</u>				
Investment intensity negative	-.403	-	-15.89	.157
Investment intensity positive	-.307	-	- 4.48	.012
Finished goods/revenue negative deviation	-.068	+	+ 1.52	.001
Finished goods/revenue positive deviation	-.169	-	- 2.28	.003
<u>Regression 4</u>				
Investment intensity negative	-.413	-	-16.31	.164
Investment intensity positive	-.307	-	- 4.17	.011
Raw material plus work- in-process/revenue negative deviation	-.024	+	+ 3.90	.009
Raw material plus work- in-process/revenue positive deviation	-.148	-	- 3.22	.006

components, the lower a business's ROI. Significant deviations from par should signal managers that based on their business's own resources and strategic position the actual level of working capital/revenue or of its components is abnormal, and therefore may merit adjustment. From an operational point of view, failure to heed the signals given by the par models will most likely lead to poor performance.

The Full ROI model. The deviation from par variables were tested using the full ROI model, just as they were in the abbreviated ROI model discussed above. The results reported in Table 5-8 were not altered in any appreciable way when curvilinear relations were fit.

Insights and implications. Evidence derived from testing the full ROI model is not generally supportive of the hypothesis that the greater the positive or negative deviation from par of working capital or of its components, the lower the ROI. In addition, the inclusion of the respective deviation from par variables contributed little or nothing to the explanatory power of the full ROI model. Thus the influence of the deviation from par variables, while clearly evident in the bivariate abbreviated ROI model, is suppressed in the full ROI model. This result is not surprising since the full ROI model is constructed using the well-specified and thoroughly-tested PIMS Par ROI model. In all likelihood, the deviation from par variables were dominated by some more powerful variables or combination of variables already present in the PIMS Par ROI model.

Table 5-8. Regression Results: Full ROI Model

	<u>Correlation with ROI</u>	<u>Expected sign of coefficient in model</u>	<u>Sign of coefficient in model and t ratio</u>	<u>Contri- bution to R²</u>
<u>Regression 1</u>				
All independent variables in PIMS Par ROI model				
Working capital/revenue negative deviation	-.176	+	+ .64	.000
Working capital/revenue positive deviation	-.223	-	- .78	.000
<u>Regression 2</u>				
All independent variables in PIMS Par ROI model				
Accounts receivable/revenue negative deviation	-.051	+	+ .58	.000
Accounts receivable/revenue positive deviation	-.139	-	+ .50	.000
<u>Regression 3</u>				
All independent variables in PIMS Par ROI model				
Finished goods/revenue negative deviation	-.068	+	+ .13	.000
Finished goods/revenue positive deviation	-.169	-	+ .07	.000
<u>Regression 4</u>				
All independent variables in PIMS Par ROI model				
Raw material plus work- in-process/revenue negative deviation	-.024	+	+2.26	.004
Raw material plus work- in-process/revenue positive deviation	-.148	-	-1.10	.001

C H A P T E R V I

SUMMARY AND CONCLUSIONS

Summary

Introduction. As corporations have grown larger and more diversified, the strategic management of their product-line working capital has taken on increasing importance. Deciding which inventory and receivables levels are appropriate for a given product-line environment is an ongoing challenge for corporate planners and product-line managers. Since a major portion of the investment in working capital for manufacturing corporations is ongoing or permanent in nature, it is crucial that managers take a strategic or longer-term approach in the analysis of their working capital needs. Until recently, the major analytical data bases available for research in strategic working capital management were historical industry averages and the past operating records of the individual product lines. The excessive aggregation of industry averages cloud operating relationships relevant to specific product-line environments. At the opposite extreme, the past operating records of individual product lines normally provide a myopic type of analytical base for planning and evaluation. Due to these weaknesses in the generally available data, empirical research has not, up to now, yielded any significant set of tested integrated relationships to guide product-line managers and corporate planners in their strategic working capital decisions.

The use of product-line data in a cross-sectional context. The current effort to provide product-line managers and corporate planners with a significant set of tested integrated relationships in the working capital area has utilized the proprietary cross-sectional product-line data from the Strategic Planning Institute's (SPI) Profit Impact of Market Strategy (PIMS) data base. The data base is broad in scope, going far beyond the balance sheet and income statement type data found in either annual or 10K reports. Clearly, product-line data such as that in the SPI data base is the ideal type to use in studying strategic product-line relationships.

Cross-sectional or "par" models were fitted to SPI data in order to determine how working capital and its components vary from one business to the next. Why, for example, do some businesses maintain high levels of accounts receivable while others operate with much lower levels? Some factors such as relative price, relative image, and share instability explain why accounts receivable levels vary among competitors within an industry. Other factors such as industry concentration and industry instability explain why accounts receivable levels differ across industries. Still other factors--sales force/revenue, order backlog, and gross margin/revenue--reflect both differences among competitors and across industries.

The modeling process. Models were built for working capital and for its components with the strategic focus maintained by employing four-year-average data for both the 1970-73 and 1974-77 periods. Thus any short-term influences on working capital and on its components--influences

which might have dominated the data for a shorter time period, thereby masking more important long-term strategic relationships--should be reduced.

The relationships hypothesized for each model were chosen in four steps: a priori hypotheses, correlation analysis, an exploratory factor analytical approach, and interactions and curvilinear relationships derived in testing preliminary models. The four final models containing the determinants compiled in steps 1 through 4 above were tested using the PIMS four-year-average data in a cross-sectional regression context. Each of the models was constructed from 50% of the 1970-73 observations, randomly selected. Analysis of covariance tests are used to test the coefficients of each model for stability across subsamples employing the remaining 50% of the 1970-73 observations, and for stability across time periods using the 1974-77 observations.

The final stage of the study involved examining the relationship between business's actual working capital and its components (relative to their model's predicted values) and operating performance, as measured by ROI. One useful way of showing that the models have value in an operational context is to show that failure to heed the signals given by the models generally leads to less favorable operating performance than would result from heeding such signals. Since many managers view ROI as the most useful measure of operating performance [24; pp. 28 ff], the relationship between ROI and deviation from par is utilized as a measure of the operating relevance of the par models.

The relationship between ROI and deviation from par was tested, individually, for working capital and each of its components, using two

different ROI models:

1. An abbreviated ROI model which related ROI to deviation from par and a control variable, investment intensity, and
2. A full ROI model in which deviation from par was added to a thoroughly tested proprietary model, currently in use [11; p. 14]

An inverse relationship between ROI and the positive or negative deviation from par was hypothesized for both ROI models tested. In the section which follows, the major conclusions drawn from constructing both the par models and the ROI models are discussed.

Conclusions

The findings and the major conclusions drawn from these results are presented in five parts:

1. Hypothesis testing
2. Variation explained
3. Analysis of covariance
4. The par models and operating performance
5. Areas for further study

Since the results of hypothesis testing and the conclusions drawn are pivotal in an empirical study of this nature, these will be discussed first.

Hypothesis testing. As explained in detail in Chapter V and in Appendix C, the vast majority of relationships hypothesized for the Par Working Capital and par component models are supported by the evidence from the empirical tests performed on them. In the process of evaluating the test results, a number of strategic factors were found to be of major

importance as determinants of working capital either because of their strong impact in one model or their pervasive influence in several models.

Strategic factors explain how working capital or its components may vary among competitors within an industry, across industries, or reflect both differences among competitors and differences across industries. A knowledge of factors which explain variation within an industry is advantageous in analyzing a business's position relative to its competitors while a knowledge of factors explaining variation across industries is helpful in understanding a business's relative position in a portfolio of businesses operating in different industries. An understanding of factors which explain both types of variation is of general usefulness to product-line managers and planners. The most influential strategic factors found in this study have been split into three groups according to the type of variation explained.

Factors explaining variation within an industry. The evidence points to the existence of a tradeoff between a business's image for quality and service relative to the competition and the level of working capital needed. If a business has a poor relative image, it is more likely to compete by providing both a readily available product and liberal credit terms; but if a business has a favorable relative image, it can get away with maintaining a lower level of working capital and rely on its relative product image and company reputation to keep its customers satisfied.

A second finding shows that a business's market share instability is positively related to its level of accounts receivable. The greater

the instability of market share, the less certain a business can be that current customers will remain loyal or that potential customers will choose the products of this business. Therefore such a business has an incentive to use a liberal credit policy and a flexible collection policy to encourage sales.

In support of Schwartz's hypothesis [30] in which trade credit is viewed as part of the selling price, a third finding reveals that the level of accounts receivable increases with relative selling price. The greater a business's selling price relative to that of its competitors, the greater the need for a liberal credit policy as a means of remaining attractive to current customers and attracting new customers.

Factors explaining variation across industries. The evidence points to the existence of a tradeoff between a business's degree of industry sales instability and its level of working capital. The greater the instability of an industry's sales over the long term, the less predictable is product demand and the greater is the potential for cash flow problems. The uncertainty of product demand leads a business to maintain lower levels of finished goods inventories in order to reduce the risk of being left with excess or obsolete stock. The greater potential for cash flow problems acts to discourage a business from offering liberal credit terms.

Empirical support was also found for the existence of a positive relationship between the percentage of sales exported in a business's industry and the business's level of working capital. The greater the level of industry exports, the greater the possibility that businesses in the industry will maintain part of their production operations in

foreign countries in order thereby to reap some cost savings. Such overseas production lengthens the supply pipeline, thereby increasing raw material and work-in-process inventory levels. In addition, trade with foreign countries generally requires a longer billing process and therefore a higher level of accounts receivable. These results suggest that businesses in export-oriented industries should expect to carry relatively high levels of working capital.

Similarly, a positive relationship was found between the percentage of sales imported by a business's industry and the business's level of finished goods inventory. Domestic businesses have a potential advantage over foreign businesses competing in their served market: they should be able to ship more quickly, more dependably, and at lower cost because of their closer proximity to their markets. Thus the greater the competition from imports, the greater the need for domestic businesses to counter the competition with quick and dependable shipments, and therefore the greater the level of finished goods inventory required.

The results also suggest the existence of an inverse relationship between the degree of competition in a business's served market and a business's level of raw material plus work-in-process inventory. The greater the degree of competition in a business's served market, the smaller the return on investment, risk constant, and the greater the need to economize on raw material and work-in-process buffer stocks in order to maintain a "normal" rate of return. These results suggest that the degree of competition in each served market should be analyzed before establishing raw material and work-in-process guidelines for diverse businesses.

Factors explaining variation both among competitors and across industries. A business's level of capacity utilization was found to be positively related to the level of accounts receivable and negatively related to the level of raw material plus work-in-process inventory. A business should take account of this tradeoff in determining the most profitable level of capacity to utilize. In general, the greater the percent of capacity utilized, the greater will be the amount of credit extended to attract customers. Alternatively, the greater the capacity utilized the lower will be the level of work-in-process inventory needed because generally there will be inventory economies derived from generating greater output from the same amount of plant and equipment.

The evidence supports a positive relationship between a business's capital intensity, as measured by gross book value/revenue, and the level of finished goods inventory. The more capital intensive the production process, the greater the level of finished goods inventory necessary to insure an efficient balance between utilization of capital and product demand.

The empirical results suggest that the extent to which a business's products are made to order, versus their being standardized, is positively related to raw material plus work-in-process inventory and negatively related to finished goods inventory. This occurs because the more made to order, or the less standardized the product, the more complex the materials requirements and production process, thereby increasing raw material plus work-in-process. Similarly, the more made to order the product, the greater the possibility of shipping immediately upon

completion or quickly thereafter, thereby decreasing the need for finished goods inventory.

An inverse relationship was found to exist between the level of finished goods inventory and real sales growth. The greater a business's real sales growth, the greater the demand for its products, the less the buildup of finished products in inventory, and the lower the level of finished goods inventory needed. Managers and corporate planners should apply their understanding of this strategic relationship in setting operating guidelines and in calculating future funds requirements.

Another inverse relationship was found to exist between the level of working capital and the degree of media-induced brand loyalty, as measured by an advertising expense/revenue and advertising plus promotion expense/revenue. By creating a captive market made up of those customers who will buy only its brand, media-induced brand loyalty gives a business a competitive edge. Thus the greater the media-induced brand loyalty, the less the need to use quick delivery or liberal credit terms as selling tools and the lower the levels of both finished goods inventory and accounts receivable.

The evidence further suggests the existence of a positive relationship between the level of working capital and the influence of the sales force within a business and of the channels of distribution outside a business, as measured by sales force expenses/revenue, gross margin to channels, and purchase frequency of immediate customers. The greater the pressure from selling groups to have readily available product(s), quick delivery, and liberal credit terms, the greater the level of both

inventory and accounts receivable. The powerful influence of selling pressure on working capital levels should be considered explicitly in determining a business's appropriate level of working capital and of its individual components. In addition, since product availability, quick delivery, and liberal credit terms are not "free goods," the sales force and channels of distribution should be held accountable for their influence on working capital levels.

Finally, supply considerations, such as the extent to which alternate sources are available, material is purchased from components, or material is purchased from a business's three largest suppliers, are used to measure the degree of stability and dependability of the source(s) of supply. Test results indicate that the greater the stability or dependability of the source of supply, the lower the level of raw material buffer stocks needed to maintain continuous production. Thus the stability and dependability of the source(s) of supply should be considered in choosing the appropriate level of raw material inventory.

Some practical implications of the findings. As we have seen, working capital levels tend to increase with the degree of selling pressure, capital intensity, percentage of industry sales imported or exported, price effects, and market share instability. On the other hand, working capital levels tend to decrease with the degree of supply dependability, media-induced brand loyalty, real sales growth, degree of competition, industry sales instability, and reputation for service and quality. The high cost of corporate capital today makes the implications of these relationships particularly relevant. It should be possible to use these findings to derive practical guidelines that would

improve the efficiency with which working capital is allocated. In such matters as deciding whether or not to pursue various policies--evaluating acquisition candidates, making entry or exit decisions, or judging the performance of existing management--a knowledge of the determinants of working capital and its components would be useful. Six specific examples of how such considerations might enter into these decisions are discussed below.

1. The creation of consistent policies between the sales and production departments can lead to economies in the use of working capital. If sales managers are made to understand that selling pressure increases the level of working capital and, in addition, if they are held responsible for the working capital impact of the policies that they pursue, consistent goals can be established between the two departments and economies thereby realized.

2. In contemplating a move into the rapidly growing international market, planners should be aware that increases in the amount exported or imported often lead to substantial increases in working capital requirements. Thus the probable increase in working capital over and above the business's usual domestic needs must be considered in making the decision to export or import.

3. Similarly, planners should incorporate a knowledge of the trade-off between media-induced brand loyalty and working capital levels in their decisions involving the allocation of corporate resources to product lines. By recognizing that product lines whose customers show a high degree of brand loyalty need less working capital than product

lines with less consumer loyalty, planners can allocate corporate resources more effectively.

4. Managers and planners should consider a business's degree of market share instability in forecasting working capital needs. Businesses with unstable market shares can be expected to require a relatively large investment in accounts receivable, while managers with stable market shares should need relatively low levels of receivables.

5. In analyzing potential acquisition candidates, both managers and planners should be aware that the candidate's reputation for quality and service can be expected to have a significant impact on its working capital needs. Thus candidates with relatively good reputations can be expected to require a substantially lower investment in working capital than candidates with relatively poor reputations for quality and service.

6. Corporate managers should be aware, in assessing product-line performance, that capital-intensive businesses will often need substantially more working capital than their more labor-intensive counterparts. In measuring the performance of capital intensive businesses, the probable need for relatively high levels of working capital should be recognized.

Summary. By dividing the major strategic factors found, according to the type of variation explained by them, an important strength of the par modeling process is brought to light. Cross-sectional modeling makes possible the analysis of the characteristics of many diverse businesses in terms of their common or unique variation. Traditionally businesses have been analyzed by dividing them into industry groups--

oil, steel, etc.--and business type groups--consumer durables, capital goods, etc.--and noting the major differences between groups. While this type of analysis is helpful in determining what differences exist between groups, it does not focus on the crucial question: What factors cause these differences? Hopefully, the major strategic factors discussed above help to provide an answer.

Variation explained. In addition to providing strong support for the major strategic factors discussed above, each of the par models explains a substantial portion of the variation in each dependent variable, ranging from a low of .203 to a high of .460. Thus the par models may be useful in determining the "normal" level for working capital and for its components.

As mentioned in Chapter V, while the factors responsible for the unexplained variation in each par model cannot be known with certainty, the following, largely uncontrollable factors, are thought to contribute to some extent: (1) measurement error; (2) excluded variables; (3) differing costs of capital between firms and (4) mistakes made by businesses. The likely influence of each of these factors is discussed below.

Measurement error. In view of the fact that each business inputs over two hundred data items, some measurement errors are almost inevitable. Moreover, the very nature of the information requested often introduces the likelihood of measurement error, for example information on product quality, market share, relative direct costs, relative degree of vertical integration, etc. These errors are minimized by the Strategic

Planning Institute's ongoing efforts:

1. To provide respondents with a clear understanding of the information being requested on a question-by-question basis, and
2. To test the raw data inputed for inconsistencies, putting only the consistent data in the research data bases of the PIMS program

These efforts should, to a large extent, reduce the possibility of errors of great magnitude.

The most likely errors are expected to be those made by respondents in answering questions which require estimates. Since answers of this type can vary for equivalent facts with the respondent, variation in the estimates could be caused by differences between the respondent's interpretation of the question or the available information. While variation of this type is expected to increase the unexplained variation in each model, unless it follows a systematic pattern, no bias in model coefficients should result.

Excluded variables. With over four hundred variables or forms of variables available in the PIMS data base, the author acknowledges that some variables may well have been overlooked--variables whose inclusion would have increased each model's explained variation. On the other hand, the addition of some variables, not currently available in the data base, but of direct relevance to strategic working capital decisions, could have a major impact on each model's level of explained variation. These additional variables are described in the Areas for Further Research section.

Differing costs of capital between businesses. The investment in working capital is expected to provide a return in excess of the financing costs of working capital. Businesses with similar strategic

characteristics and similar values for key determinants may, however, encounter different costs of financing working capital and thus may choose different working capital strategies. Differing costs of capital are expected, therefore, to be a source of unexplained variation. Since the differences in the cost of working capital across business are not thought to follow a systematic pattern, model coefficients are not expected to be biased by this effect.

Mistakes made by businesses. Since the par models are descriptive in nature, they reflect failure as well as success. For example, suppose one of two businesses with similar working capital characteristics stocks too much raw material because of an incorrect sales forecast, while the other stocks an appropriate amount. Despite their similarities, their differing raw material levels will lead to unexplained variations in raw material inventories. While this source of unexplained variation is expected to exist, the four-year averaging of the data, as well as the large number of businesses analyzed, are expected to minimize its significance.

Analysis of covariance. Analysis of covariance was used to test whether or not the coefficients of the Par Working Capital model and of the par component models are stable across the two subsamples from the 1970-73 time period and/or stable across the 1970-73 and 1974-77 time periods. No significant differences are found at the 5% level, either across subsamples or across time periods. Thus model coefficients were not found to change appreciably either across subsamples or across time periods. The favorable tests for stability over time are particularly encouraging

because they provide support for the ongoing or strategic nature of the relationships tested. The question of whether the par models tested can be used by managers and planners to improve operating performance is discussed in the following section.

The par models and operating performance. While the substantial variation explained by the par models suggests that the models can be useful in estimating a business's par or "normal" level for working capital or for its components, the crucial question is: Does the deviation of a business's actual level from its estimated par level have any impact on operating performance? The results of testing the full ROI model and the abbreviated ROI model shed light on this question.

The full ROI model. The empirical evidence does not generally support the hypothesis that the greater the positive or negative deviation from par, the lower a business's ROI. It is thought that the effect of the deviation from par variables is dominated by some combination of variables already present in the PIMS ROI model. This result is not surprising since the full ROI model is constructed using the well-specified and thoroughly tested PIMS ROI model--a model which contains many of the same variables used to explain working capital variability.

The abbreviated ROI model. Strong support was found for the hypothesis that the greater the positive or negative deviation from par, the lower a business's ROI. Thus significant deviations from par should signal managers that based on their business's own resources and strategic position, the actual level of working capital or of its components is abnormal and therefore may well merit adjustment. Therefore, from an

operational point of view, failure to heed the signals given by the par models may often lead to poor performance.

Areas for further study. Further study is suggested in order to (1) improve the specification of each model and (2) monitor the stability of coefficients over time. Improved specification of the models would require continuing examination of potential explanatory variables, including their properties in linear, curvilinear and interactive contexts. While this continuing investigation could be carried out with the currently available PIMS variables, the inclusion of some new variables in the data base could yield important insights as well as substantially increasing the explanatory power of the models. Table 6-1 contains a list of the new variables thought to hold the most promise.

The model coefficients were found to be stable over the two four-year time periods tested. Continued stability tests over time, as additional years are added to the data base, would, however, be useful in checking the stability of model coefficients and in spotting possible changes in previously stable strategic relationships.

Table 6-1. Suggested new variables

Accounts receivable

1. Rigor with which past due accounts are collected
2. Credit terms
3. Age of uncollected accounts
4. Bad debt expense
5. Collection costs
6. Does this business factor its accounts receivable?

Inventory

1. Relative speed of delivery to customers
2. Estimated value of sales lost through stockouts
3. Speed of delivery by suppliers
4. Dependability of suppliers
5. Availability of subcontractors
6. Work-in-process inventory as an individual variable
7. Raw material inventory as an individual variable
8. In-transit inventory
9. Shipping charges
10. Warehousing expense

General

1. Rank the influence of the business's finance, marketing, production groups, and the corporate planning group on the level of working capital, accounts receivable, finished goods inventory, work-in-process inventory, and raw material inventory
2. Accounts payable as an individual variable

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APPENDIX A

Technical Discussion: The Par Working Capital Model

Hypothesis 1: Industry instability

X_1 Industry instability*

Variable #80 line #407

Expected sign: negative, but decreasing at a decreasing rate
at higher levels of instability

Reasoning: The greater the long term variability of industry sales, the less predictable product demand, the greater the risk of being left with excess or obsolete finished goods inventory. In addition, the greater the long term variability in industry sales, the more uncertain the market environment, the greater the potential for cash flow problems, and the less the incentive to establish a liberal credit policy. Thus the greater the long term variability in industry sales, the lower the level of both finished goods inventory/revenue and accounts receivable/revenue and the lower the level of working capital/revenue. Working capital/revenue is expected to decrease at a decreasing rate at higher levels of instability because economic capacity utilization dictates that some minimum level of finished goods inventory be maintained and because some minimum level of accounts receivable is needed to facilitate customer purchases.

*The ten-year variability in sales for this business's S.I.C. group

Hypothesis 2: Media induced brand loyalty

X_2 Advertising media expenses $\div$ revenue (average)

Variable #157 lines #212 $\div$ #201

Expected sign: negative

Reasoning: The greater a business's level of media advertising, the greater the media induced brand loyalty, the larger the proportion of the business's sales that are "captive," the less the need to use accounts receivable/revenue as a selling tool, and the lower the level of working capital needed to support a given level of sales.

Hypothesis 3: Reputation for service and quality

X_3 Relative image*

Variable #330 line #333

Expected sign: negative, but decreasing at a decreasing rate for businesses with the best product images

Reasoning: The better the end user's perception of a business's product image and company reputation, the stronger the business's competitive position, the greater the demand for its products and the less the need to use accounts receivable/revenue and finished goods inventory/revenue as selling tools in dealing with immediate customers or end users. Working capital/revenue is expected to decrease at a decreasing rate as a business's reputation becomes "much better" than that of its leading competitors because economic capacity utilization dictates that some minimum level of finished goods inventory be maintained and because some minimum level of credit is needed to facilitate customer purchases.

*Compared to its three largest competitors were end users' perceptions of this business's product image and company reputation (for quality, dependability, etc.):

1 = much worse

2 = somewhat worse

3 = about the same

4 = somewhat better

5 = much better

Hypothesis 4: Selling pressure

X_4 Sales force ÷ revenue (average)
Variable #147 lines #210 ÷ #201

Expected sign: positive

Reasoning: The greater the percent that sales force expenses are of sales, the greater the pressure on a business to meet individual customer needs, the greater the pressure to ship quickly and to provide liberal credit, and the greater the level of working capital/revenue needed to support a given level of sales.

X_5 Gross margin channels*
Variable #38 line #137

Expected sign: positive

Reasoning: The greater the gross margin earned by distribution channels, the greater the incentive these distribution channels have to be supplied quickly, the greater the pressure on the business to ship quickly and the greater the level of raw material plus work-in-process inventory/revenue and finished goods inventory. In addition, the greater the gross margin earned by distribution channels, the more important these channels are in the selling process, and the greater the business's incentive to meet their credit needs. Pressures to ship quickly and to provide ample credit combine to increase the level of working capital needed to support a given level of sales.

*The approximate difference between the manufacturer's price and the selling price to end users, expressed as a percent of the selling price to end users.

X₆ Purchase frequency--immediate customers*

Variable #27 line #126

Expected sign: positive, but increasing at an increasing rate
as purchases become very infrequent

Reasoning: The less frequent purchases by immediate customers, the more "tailor made" the product, the more "small batch" the production process, and the greater the level of raw material and work-in-process inventory needed to support a given level of sales. The more "tailor made" the product the greater the extent to which products can be shipped upon completion, and the lower the level of finished goods inventory needed to support a given level of sales. The less frequent the purchases by immediate customers, the less the use of distribution channels, the more personalized the relationship between buyer and seller, and the greater the pressure from salesmen to extend liberal credit. On balance the increases in raw material, work-in-process, and accounts receivable will more than offset the decrease in finished goods inventory as purchases become less frequent and the level of working capital needed to support a given level of sales will increase. As purchases become very infrequent, economic capacity utilization dictates that a minimum level of finished goods inventory be maintained. As this minimum level is reached, finished goods inventory stops decreasing, no longer acting as a moderating force on working capital increases, and working capital/revenue begins increasing at an increasing rate.

*The business's immediate customers (i.e., those from whom the business receives purchase orders) typically purchase its products or services:

- 1 = weekly or more frequently
- 2 = between once a week and once a month
- 3 = between once a month and once every six months
- 4 = between once every six months and once a year
- 5 = between once a year and once every five years
- 6 = between once every five years and once every ten years
- 7 = other

Hypothesis 5: Supply

X_7 Purchases from components*

Variable #43 line #142

Expected sign: negative

Reasoning: The greater the percent of purchases of materials (the purchase component of cost of goods sold) from components of the same corporation, the greater the dependability of the source(s) of supply, the less the risk of not being supplied, the less the need for raw material/revenue buffer stocks, and on the balance the lower the level of working capital needed to support a given level of sales.

*The percent of this business's purchases of materials that were obtained from other components of the same corporation

X_8 Suppliers 3 largest*

Variable #56 line #155

Expected sign: negative

Reasoning: The greater the percent of purchases made from a business's three largest external vendors, the stronger the position of the purchaser in demanding a dependable supply from these vendors, the less the need to carry raw material/revenue buffer stocks, and on balance the lower the level of working capital needed to support a given level of sales.

*The percent of this business's external purchases of materials made from the business's three largest vendors.

Hypothesis 6: Product demand

X_9 Order backlog*

Variable #63 line #203

Expected sign: negative

Reasoning: The greater the percent order backlog, the greater the demand for a business's product(s), the less the need to use liberal credit and quick delivery as selling tools, the lower the level of accounts receivable/revenue and finished goods inventory/revenue respectively, and the lower the level of working capital needed to support a given level of sales.

*Order backlog as a percent of annual sales volume.

Hypothesis 7: Wage rate growth

 X_{10} Wage rate growth*

Variable #338 line #314

Expected sign: positive

Reasoning: The greater the growth of a business's wage rate, the greater the costs allocated to work-in-process inventory, the greater the cost of finished goods inventory, and to the extent that price increases lag cost increases, the greater the level of working capital/revenue.

*A yearly estimate of the average level of hourly wage rates paid by a business relative to the level in 1973. Included are the cost of fringe benefits and pension plans.

Hypothesis 8: Industry exports

X_{11} Industry exports*

Variable #83 line #404

Expected sign: positive, but increasing at a decreasing rate for businesses in industries with a high level of exports

Reasoning: The greater the percentage of sales exported by a business's S.I.C. group, the greater the possibility of that business maintaining part of its production operations in foreign countries in order to reap cost savings, the longer the pipeline carrying raw material and work-in-process, and the greater the amount of raw material and work-in-process needed to support a given level of sales. In addition, the greater the percentage of sales exported by a business's S.I.C. group, the longer the billing process due to customs requirements, guarantees of payment and insurance coverage, and the greater the level of accounts receivable needed to support a given level of sales. Thus the greater the industry exports, the greater the level of both raw material plus work-in-process inventory/revenue and accounts receivable/revenue, and the greater the level of working capital/revenue. Working capital/revenue is expected to increase at a decreasing rate at high levels of industry exports as businesses reach the point at which the marginal return from export operations no longer justifies the marginal costs of additional working capital.

*The total exports of all establishments in the S.I.C. group to areas outside the U.S., expressed as a percentage of their total sales both within and outside the U.S. For non-U.S. businesses, enter the exports of establishments located within the country in which the business is based.

Technical Discussion: The Par Accounts Receivable Model

Hypothesis 1: Price effects

X_1 Relative price average*

Variable #290 line #319

Expected sign: positive

Reasoning: The greater a business's selling price relative to that of its three largest competitors, the greater the relative profitability of sales, *ceteris paribus*, and the greater the incentive to use generous credit as a means of attracting new customers and keeping current customers.

*The average level of selling prices of this business's products and services, relative to the selling price of the three largest competitors

X_2 Percent change price short*

Variable #445 line #503

Expected sign: positive

Reasoning: The greater the expected increase in selling price within a business's served market, the greater the expected contribution to profit of future sales, and the greater the incentive to use generous credit to attract new customers and/or to dissuade current customers from cutting back on purchases after the price increase(s).

*A forecast of most likely rate of change in the selling prices of products within the business's served market.

Hypothesis 2: Market share instability

X_3 Your share instability*

Variable #374 line #306

Expected sign: positive

Reasoning: The greater the instability of a business's market share, the less certain the business can be that current customers will remain loyal, or that potential customers will choose the products of this business. Thus an incentive exists for using generous credit extension as one means of keeping current customers loyal and of attracting potential purchasers.

*Instability equals the average percentage difference from an exponential trend of a business's market share levels

Hypothesis 3: Gross margin

X_4 Gross margin/revenue (average)*

Variable #157 lines [#205-(#206+#215)]/#201

Expected sign: positive

Reasoning: The greater a business's gross margin, the greater the marginal return for each additional dollar of sales. The greater the marginal return, the greater the amount of credit risk that can be accepted before further credit extension becomes uneconomic, and the greater the level of accounts receivable.

*Gross margin equals value added minus manufacturing and physical distribution expenses and minus depreciation expense.

X_5 Channels via retail*

Variable #35 line #134

Expected sign: positive

Reasoning: The greater the proportion of a business's sales that are made to end users via company-owned distribution facilities, the lower the cost of distribution, the higher the gross margin, the higher the marginal return for each additional dollar of sales, the greater the amount of credit risk that can be accepted before further credit extension becomes uneconomic, and the greater the level of accounts receivable.

*The percent of sales of this business that are made to end users via company-owned retail or wholesale distribution facilities.

X_6 Industry concentration ratio*

Variable #81 line #402

Expected sign: positive, but increasing at an increasing rate at higher levels of concentration

Reasoning: The greater the concentration in a business's S.I.C. group, the higher and the more stable the prices of products sold, the greater the degree of non-price competition, the higher price is relative to marginal cost, and the greater the incentive to use liberal credit as a means of keeping customers and/or attracting new customers. Accounts receivable/revenue is expected to increase at an increasing rate, as the concentration of the industry increases due to the increased incentive of industry members to maintain their oligopolistic advantage through price coordination.

*The percentage of sales or shipments by establishments in this business's S.I.C. group accounted for by the sales or shipments of the four largest establishments in the S.I.C. group (include this business if it is one of the four largest).

X₇ Vertical integration backward*

Variable #29 line #138

Expected sign: positive

Reasoning: The greater the degree to which a business is backward integrated, the lower its cost of raw materials and components, the higher its gross margin and the greater the incentive to use accounts receivable/revenue to generate additional sales.

*When measured relative to its three largest competitors in this business:

1 = relatively less backward integration

2 = relatively the same backward integration

3 = relatively more backward integration

Hypothesis 4: Selling pressure

X₈ Sales force/revenue (average)*

Variable #147 lines #210 ÷ #201

Expected sign: positive

Reasoning: The selling group within a business would be expected to extend credit liberally to generate additional sales. Thus the greater the percent that sales force expenses are of sales, the greater the influence of the selling group on accounts receivable/revenue policy and the greater the level of accounts receivable/revenue.

Hypothesis 5: Brand loyalty

X₉ Advertising and promotion/revenue (average)*

Variable #152 lines #211 ÷ #201

Expected sign: negative

Reasoning: The greater the degree of media advertising and sales promotional efforts, the greater the brand loyalty induced, the larger the proportion of the business's sales that are captive, and the less the need to use accounts receivable/revenue as a selling tool.

Hypothesis 6: Personalized customer relationships

X₁₀ Standardization*

Variable #9 line #108

Expected sign: positive

Reasoning: The greater the degree to which products are made to order, the more personalized a business's relationship with its customers, the more tailored credit extension will be to individual customer needs, the less "heavy handed" the collection policy, and the greater the level of accounts receivable/revenue.

*Are the products of this business:

0 = more or less standardized

1 = produced to order for individual customers

X₁₁ Purchase frequency--immediate customers*

Variable #27 line #126

Expected sign: positive

Reasoning: The more infrequent purchases by immediate customers, the less the use of distribution channels, the more personalized the relationship between the business and its customers, the more tailored credit extension will be to individual customer needs, the less "heavy handed" the collection policy, and the greater the level of accounts receivable/revenue.

*The business's immediate customers (i.e., those from whom the business receives purchase orders) typically purchase its products or services:

1 = weekly or more frequently

2 = between once a week and once a month

3 = between once a month and once every six months

4 = between once every six months and once a year

5 = between once a year and once every five years

6 = between once every five years and once every ten years

7 = other

Hypothesis 7: Product demand

X₁₂ Order backlog*

Variable #63 line #203

Expected sign: negative

Reasoning: The greater the order backlog as a percent of sales, the greater the demand for a business's product, the stronger the business's bargaining position vis-à-vis buyers, the less the need to use accounts receivable/revenue as a selling tool and the lower the level of accounts receivable/revenue.

*The percent that order backlog is of annual sales

X₁₃ Relative image average*

Variable #330 line #333

Expected sign: negative

Reasoning: The better the end user's perception of the product image and company reputation, the greater the degree of product differentiation and brand loyalty, the greater the demand for the business's product(s), the stronger the business's bargaining position vis-à-vis immediate customers and end users, the less the need to use accounts receivable/revenue as a selling tool, and the lower the level of accounts receivable/revenue.

*Relative to the business's three largest competitors were end users' perceptions of product image and company reputation (for quality, dependability, etc.) for this business

1 = much worse

2 = somewhat worse

3 = about the same

4 = somewhat better

5 = much better

Hypothesis 8: Industry instability

X₁₄ Industry instability*

Variable #80 line #407

Expected sign: negative, but decreasing at a decreasing rate
at higher levels of instability

Reasoning: The greater the long term variability of industry sales, the more uncertain the market environment, the greater the potential for cash flow problems, and the less the incentive to establish a liberal credit policy. Accounts receivable/revenue will decrease at a decreasing rate at higher levels of instability due to offsetting pressures to provide some minimum level of credit to facilitate customer purchases.

*The ten-year variability in sales for this business's S.I.C. group.

Hypothesis 9: Industry exports

X₁₅ Industry exports*

Variable #83 line #404

Expected sign: positive

Reasoning: The greater the percentage of sales exported by a business's S.I.C. group, the longer the billing process due to customs requirements, guarantees of payment, and insurance coverage, the longer the collection period, and the greater the level of accounts receivable needed to support a given level of sales.

*The total exports of all establishments in the S.I.C. group to areas outside the U.S., expressed as a percentage of their total sales both within and outside the U.S. For non-U.S. businesses, enter the exports of establishments located within the country in which the business is based.

Hypothesis 10: Process research and development

X₁₆ Process research and development/revenue

Variable #137 lines #208 ÷ #201

Expected sign: negative

Reasoning: The greater the percentage that process research and development expenses are of sales, the greater the degree of patent protection, the stronger the market position, the more able the business is to substitute process research and development expenses for liberal credit and the lower the level of accounts receivable needed to support a given level of sales.

Hypothesis 11: Capacity utilization

X₁₇ Capacity utilization*

Variable #236 line #236

Expected sign: positive

Reasoning: The greater the percent of standard capacity** utilized, the higher the volume of output produced, the greater the level of sales needed, the greater the use of accounts receivable as a sales tool, the greater the extent to which marginal customers will be granted credit and/or the more liberal credit terms generally, and the higher the level of accounts receivable needed to support a given level of sales.

*Capacity utilization is the percent of standard capacity utilized on the average during the year, including production for inventory.

**Standard capacity is the sales value in current dollars of the maximum output that this business can sustain with (1) facilities normally in operation and (2) current constraints (e.g., technology, work rules, labor practices, etc.).

Technical Discussion: The Par Finished Goods Model

Hypothesis 1: Standardization

X_1 Standardization*

Variable #9 line #108

Expected sign: negative

Reasoning: The greater the degree to which the product is made to order, the less the need to maintain finished goods inventory/revenue buffer stocks because, when completed, "tailor made" products can be shipped immediately.

*This is a categorical variable:

0 = more or less standardization for all customers

1 = produced to order for individual customers

X_2 End user = manufacturer*

Variable #14 line #113

Expected sign: negative, but decreasing at a decreasing rate

Reasoning: The greater the percentage of a business's output that is used by manufacturers, the more intricate the production process, the greater the proportion of small batch production, the greater the degree to which the product is "tailor made," and the less the need to keep finished products in inventory. As the percentage of output that is used by manufacturers increases, finished goods inventory decreases at a decreasing rate as a minimum level of finished goods inventory is reached. This minimum level is largely dictated by the need to keep capacity utilization at economic levels.

*The percentage of output of this business for which manufacturers are end users.

$X_1 * X_7$ Interaction between Standardization and Industry imports
 Variables #9, #84 lines #108, #405
 Expected sign: negative
 Reasoning: The less standardized, i.e., the more "tailor made," the product, the lower the level of finished goods inventory needed. Business in industries which import a relatively large proportion of total sales, and which produce a "tailor made" product will need lower finished goods inventories because customized products can normally be shipped upon completion and because competition with imports does not involve maintaining large finished goods inventories to promote quick delivery (as it could with more standardized products).

Hypothesis 2: Capital intensity

X_3 Gross book value* ÷ Revenue (average)
 Variable #201 lines #223 ÷ #201
 Expected sign: positive
 Reasoning: The more capital intensive the business, i.e., the greater the gross book value as a percent of sales, the more costly are drops in capacity utilization, and the greater is the incentive to maintain level production during slack periods, thereby building finished goods inventory/revenue.

*The original value of buildings, land and manufacturing equipment, plus all transportation equipment owned.

$X_4 * X_8$ Gross book value/Revenue*Real sales growth
 Variables #201, #367 lines #223 ÷ #201, #201 ÷ #312
 Expected sign: positive
 Reasoning: When a business is highly capital intensive, a rapid rate of real sales growth and the associated high product demand does not lead to lower finished goods inventory because economic capacity utilization dictates level production during slack periods, and a concurrent build-up of finished goods inventory. This build-up of finished goods inventory more than offsets the finished goods decreasing effect of high product demand.

Hypothesis 3: Selling pressure

X_4 Sales force $\div$ Revenue (average)

Variable #147 lines #210 $\div$ #201

Expected sign: positive

Reasoning: The greater the percent that sales force expenses are of sales, the greater the business's commitment to individual customer service, the greater the pressure to ship quickly and dependably, and the greater the finished goods inventory/revenue buffer stock needed.

X_5 Gross margin channels*

Variable #38 line #137

Expected sign: positive, but increasing at a decreasing rate at higher percent gross margins to channels

Reasoning: The greater the gross margin earned by distribution channels, the greater the incentive these distribution channels have in being supplied quickly and in adequate quantity, the greater the pressure on the business to keep them supplied, and the greater the level of finished goods buffer stock held. Finished goods inventory will increase at a decreasing rate at higher percent gross margin to channels due to offsetting pressures to keep the carrying costs of finished goods inventory in balance.

*The approximate difference between the manufacturer's price and the selling price to end users, expressed as a percent of the selling price to end users.

Hypothesis 4: Brand loyalty

X_6 Advertising media expenses $\div$ Revenue (average)

Variable #157 lines #212 $\div$ #201

Expected sign: negative

Reasoning: The greater the level of media advertising, the greater the media induced brand loyalty, the less the need to use quick delivery as part of the marketing effort, and the lower the level of finished goods inventory/revenue buffer stocks.

Hypothesis 5: Non-price competition

X_7 Suppliers integrated forward*

Variable #59 line #158

Expected sign: positive

Reasoning: The greater the competition in your served market from suppliers, the greater the need to compete using non-price competition, the greater the use of quick and dependable deliveries as a competitive tool, and the greater the level of finished goods inventory/revenue buffer stocks needed.

*This is a categorical variable:

Are any of this business's three largest external vendors integrated forward:

0 = no

1 = yes, but not in the market this business serves

2 = yes, and into this served market

X_8 Industry imports

Variable #84 line #405

Expected sign: positive

Reasoning: Domestic businesses have a potential advantage over foreign businesses competing in their served market--they should be able to ship more quickly and more dependably (at lower cost) due to geographical considerations alone. Thus the greater the competition from imports, the greater the tendency for domestic businesses to counter the competition with quick and dependable shipments, and the greater the level of finished goods inventory/revenue buffer stocks needed.

*The percent of S.I.C.-group sales within the U.S. accounted for by establishments located outside the U.S. For non-U.S. businesses, enter the imports into the country in which the business is based.

Hypothesis 6: Real sales growth

X_9 Real sales growth*

Variable #367 lines #201 ÷ #312

Expected sign: negative

Reasoning: The greater a business's real sales growth, the greater the demand for its products, the less likely it is that finished products will accumulate in inventory, and the lower the level of finished goods inventory/revenue needed to support a given level of sales.

*Real sales growth equals net sales (+lease revenues) divided by an index of material prices for this business in which 1973 = 100%.

Hypothesis 7: Industry instability

X_{10} Industry instability*

Variable #80 line #407

Expected sign: negative, but decreasing at a decreasing rate at higher levels of instability

Reasoning: The greater the long term variability of industry sales, the less predictable is product demand, the greater the risk of being left with excess and/or obsolete finished goods inventory and the lower the level of finished goods buffer stocks needed. At higher levels of instability, the level of finished goods inventory will decrease at a decreasing rate, as a minimum level of finished goods is reached, a level that is dictated by economic capacity utilization.

*Measures the variability in sales for this business's S.I.C.-group for the last ten years

Hypothesis 8: Development time for new products

X₁₁ Development time new*

Variable #12 line #111

Expected sign: negative, but decreasing at a decreasing rate

Reasoning: The longer the time lag between the beginning of the development effort for a new product and market introduction, the fewer new products, the lower the proportion of sales composed of new products, the less the need to fill the finished goods pipeline with inventory in anticipation of new product sales, and the lower the level of finished goods inventory. This is a curvilinear relationship in which as development time increases, finished goods inventory decreases at a decreasing rate due to the partially offsetting pressure to ship the end product quickly.

*The typical time lag between the beginning of the development effort for a new product and market introduction is:

1 = less than one year

2 = one to two years

3 = two to five years

4 = more than five years

5 = not applicable, little or no new product development occurs in this business

Technical Discussion: The Par Raw Material
Plus Work-in-Process Model

Hypothesis 1: Supply

X_1 Alternate sources of supply*

Variable #58 line #157

Expected sign: negative

Reasoning: The more available are alternate sources of supply, the less the risk of not being supplied and the less the need for raw material buffer stocks.

*This is a categorical variable:

Does this business have good alternate sources of supply for purchases?

1 = no

2 = yes, but with difficulty

3 = yes, with no difficulty

X_2 Purchases from components*

Variable #43 line #142

Expected sign: negative

Reasoning: The greater the percent of purchases of materials (the purchase component of cost of goods sold) from components of the same corporation, the greater the dependability of the source(s) of supply, the less the risk of not being supplied and the less the need for raw material buffer stocks.

*The percent of this business's purchases of raw materials that were obtained from other components of the same corporation

X_3 Suppliers 3 largest*

Variable #56 line #155

Expected sign: negative

Reasoning: The greater the percent of purchases made from a business's three largest external vendors, the stronger the position of the purchaser in demanding a dependable supply from these vendors, and the less the need to carry raw material buffer stocks.

*The percent of this business's external purchases of materials made from the business's three largest vendors.

Hypothesis 2: Standardization

X_4 Standardization*

Variable #9 line #108

Expected sign: positive

Reasoning: The greater the degree to which a business's product(s) are "made to order," the greater the degree of small batch production, the more complex the material requirements, the more intricate the production process and the greater the level of raw material and work-in-process inventory needed to support a given level of sales.

*This is a categorical variable:

0 = more or less standardized for all customers

1 = produced to order for individual customers

X_5 Purchase frequency--end users

Variable #26 line #125

Expected sign: positive

Reasoning: The less frequently a business's end users purchase its products, the less standardized the product, the more complex the material requirements, the more intricate the production operations and the greater the level of raw material and work-in-process inventories needed to support a given level of sales.

*A business's end users typically purchase its products or services:

1 = weekly or more frequently

2 = between once a week and once a month

3 = between once a month and once every six months

4 = between once every six months and once a year

5 = between once a year and once every five years

6 = between once every five years and once every ten years

7 = other

Hypothesis 3: New product production

X_6 Percent new products average*

Variable #302 line #323

Expected sign: positive

Reasoning: The greater the percent of sales accounted for by new products, the greater the initial new product inventory needed in anticipation of future sales and the greater the level of raw material plus work-in-process inventory/revenue.

*The percent of total sales that was accounted for by products introduced by this business during the three preceding years

Hypothesis 4: Product line breadth

X_7 Breadth of product components*

Variable #78 line #325

Expected sign: positive, but increasing at a decreasing rate and finally becoming negative for broader product lines.

Reasoning: As the breadth of a business's product line increases from narrower than that of competitors to being of more equal breadth, the business will become more competitive and while its raw material plus work-in-process inventory/revenue will increase due to increased raw material and work-in-process buffer stocks, its sales will increase at a faster rate and raw material plus work-in-process inventory/revenue will drop. In going from the same breadth as that of competitors to greater breadth that competitive advantages become more marginal, raw material plus work-in-process inventory increases at a faster rate than sales increases, and raw material plus work-in-process inventory/revenue increases.

*Relative to the weighted average of the product lines of its three largest competitors, estimate the breadth of the product lines of this business:

1 = narrower

2 = same

3 = broader

Hypothesis 5: Capacity utilization

X_8 Capacity utilization average*

Variable #236 line #236

Expected sign: negative

Reasoning: As the percent of standard capacity** utilized increases, given that the increase involves equipment that was initially utilized to some degree, the level of work-in-process remains constant while the level of sales increases.

*Capacity utilization is the percent of standard capacity utilized on the average during the year, including production for inventory.

**Standard capacity is the sales value in current dollars of the maximum output that this business can sustain with (1) facilities normally in operation and (2) current constraints (e.g., technology, work rules, labor practices, etc.).

Hypothesis 6: Competition

X_9 Number of competitors*

Variable #69 line #303

Expected sign: negative

Reasoning: The greater the number of competitors in a business's served market, the smaller the return on investment (risk constant), and the greater the need to economize on raw material plus work-in-process inventory/revenue buffer stocks in order to maintain a "normal" rate of return.

*This is a categorical variable:

How many businesses were competing in the served market of this business?

1 = five or fewer

2 = six to ten

3 = eleven to twenty

4 = twenty-one to fifty

5 = fifty-one or higher

X_{10} # immediate customers = 50% sales

Variable #348 lines $(\#122 * \#118) / 100.0$

Expected sign: negative

Reasoning: The greater the number of immediate customers necessary to generate 50% of annual sales, the more fragmented the buying market, the greater the competition between sellers; and the greater the need to economize on raw material plus work-in-process inventory/revenue buffer stocks in order to maintain a "normal" rate of return.

Hypothesis 7: Selling pressure

X_{11} Sales force ÷ revenue average*

Variable #147 lines $\#210 \div \#201$

Expected sign: positive

Reasoning: The greater the percent of sales force expenses, the greater the power of the sales group within the business and the more intense the pressure on inventory and production managers to avoid stockouts that would cause disruptions in the shipping schedule, hence the greater will be the level of raw material plus work-in-process inventory/revenue buffer stocks.

*Sales force expenses (including (1) compensation and expenses incurred by salesmen, (2) commissions paid to brokers or agents, and (3) cost of sales force administration) divided by yearly revenues.

X_{12} Sales to components*

Variable #45 line #144

Expected sign: positive

Reasoning: The greater the percent of a business's sales that were made to other components of the same corporation, the greater the pressure on inventory and production managers to avoid stockouts. A stockout which causes an internal shipping disruption not only means poor performance for the business but could lead to a failure by other components of the corporation to meet their shipping goals, hence there is an added incentive to maintain greater raw material plus work-in-process inventory/revenue buffer stocks.

*The percent of total sales of this business that were made to other components of the same corporation.

X₁₃ Relative image*

Variable #330 line #333

Expected sign: negative

Reasoning: The better the end user's perception of a business's product image and company reputation, the stronger the business's competitive position, the less the pressure to ship the end product quickly in order to generate sales, the less the pressure on inventory and production managers to avoid stockouts and the lower the level of raw material plus work-in-process inventory/revenue buffer stocks needed.

*Compared to its three largest competitors were end users' perceptions of this business's product image and company reputation (for quality, dependability, etc.):

1 = much worse

2 = somewhat worse

3 = about the same

4 = somewhat better

5 = much better

Hypothesis 8: Industry exports

X₁₄ Percent industry exports*

Variable #83 line #404

Expected sign: positive

Reasoning: The greater the percent of sales within an industry composed of exports, the greater the possibility that businesses in that industry will maintain part of their production operations in foreign countries in order to gain labor cost savings, material cost savings, import tax savings, shipping cost savings or some combination of these savings. By placing part of the production process in a foreign country the length of the pipeline carrying raw material plus work-in-process inventory/revenue is increased and the level of raw material plus work-in-process inventory/revenue needed to support a given level of sales is increased also.

*The percent of S.I.C.-group sales within and outside the U.S. accounted for by the exports of establishments located within the country in which the business is based.

Hypothesis 9: Direct costs

 X_{15} Purchases/Revenue

Variable #102 line #204

Expected sign: positive

Reasoning: The greater are purchases, i.e., the purchases component of cost of goods sold, specifically the cost of raw materials, subassemblies, components, supplies, etc., the greater the level of raw material necessary to support a given level of sales.

 X_{16} Manufacturing + Depreciation expenses/Revenue

Variable #122 lines (#206+#215)/#201

Expected sign: positive

Reasoning: The greater the proportion that manufacturing and depreciation costs are of total cost, the greater level of work-in-process inventory needed to support a given level of sales.

APPENDIX B

Working Capital/Revenue

Sign of Factor in Regression	Factor #	Factor Name and Highest Loading PIMS Variables	Contribution to R ²
+	19	Externally imposed constraints # 54 Government price controls -.52 # 64 Inventory accounting method .56 # 68 Location of market served .65	.061
-	14	Production method # 90 % of sales made in small batches .77 # 91 % of sales made on assembly line -.76	.041
+	5	Personal selling # 19 Number of immediate customers .57 # 29 Purchase amount--immediate customers -.57 #127 Gross margin/revenue .51 #147 Sales force expense/revenue .74 #162 Marketing expense/revenue .67 #251 Sales/salesman -.74	
-	8	Absolute advertising and promotion expense #152 Advertising and promotion expense/ revenue .81 #157 Advertising media expense/revenue .83 #162 Marketing expense/revenue .54	.048
-	13	Profitability #127 Gross margin/revenue .57 #167 Net income/revenue .82 #263 Total cash flow/revenue .57	.055
-	2	End users and external channels of distribution # 2 Type of business .71 # 13 End user = individual -.78 # 14 End user = manufacturer .59 # 18 Number of end users -.64 # 20 Concentration on purchasers of end users -.73 # 26 Purchase frequency of end users -.56 # 34 Channels of distribution go direct- ly to end users .72 # 37 Channels of distribution to re- tailers -.76 # 38 Gross margin earned on this busi- ness's products by channels of distribution -.67	.027
-	10	Reputation for quality and service #286 % superior quality products minus % inferior quality products .66 #290 Relative price of product(s) .55 #326 Relative customer service .68 #330 Relative image of product and com- pany .76	.020
+	29	End users = contractors # 17 End users = contractors .78	.020
+	16	Market share instability #335 Sum of market share changes .74 #374 Your share instability .72 #375 Total share instability .78	.013
+	6	In-house protection-vertical integration #102 Purchases/revenue -.68 #107 Value added/revenue .69 #117 Manufacturing expense/revenue .88 #122 Manufacturing plus depreciation expense/revenue .88 #239 Sales/employee -.63	.010

Accounts Receivable/Revenue

Sign of Factor in Regression	Factor #	Factor Name and Highest Loading PIMS Variables	Contribution to R ²
+	19	Externally imposed constraints	.101
		# 54 Government price controls	
		# 64 Inventory accounting method	
		# 68 Location of market served	
+	9	Customer purchase frequency	.039
		# 26 Purchase frequency of end users	
		# 27 Purchase frequency of immediate customers	
		# 28 Amount purchased by end users	
		# 36 Channels of distribution to wholesalers	
+	5	Personal selling	.037
		# 19 Number of immediate customers	
		# 29 Purchase amount-immediate customers	
		#127 Gross margin/revenue	
		#147 Sales force expense/revenue	
		#162 Marketing expense/revenue	
		#251 Sales/salesman	
-	8	Absolute advertising and promotion expense	.030
		#152 Advertising and promotion expense/revenue	
		#157 Advertising media expense/revenue	
		#162 Marketing expense/revenue	
+	14	Production method	.021
		# 90 % of sales made in small batches	
		# 91 % of sales made on assembly line	
+	16	Market share instability	.020
		#335 Sum of market share changes	
		#374 Your share instability	
		#375 Total share instability	
-	10	Reputation for quality and service	.019
		#286 % superior quality products minus % inferior quality products	
		#290 Relative price of product(s)	
		#326 Relative customer service	
		#330 Relative image of product and company	
+	29	End users = contractors	.019
		# 17 End users = contractors	
+	37	Purchases from large suppliers	.014
		# 57 % sales to business by its 3 biggest suppliers	
+	20	Backward integration	.011
		# 39 Vertical integration of business-backward	
		# 41 Vertical integration of company-backward	
		# 43 % of purchases from components of same corporation	

Finished Goods Inventory/Revenue

Sign of Factor in Regression	Factor #	Factor Name and Highest Loading PIMS Variable	Contribution to R ²
-	2	End users and external channels of distribution	.048
		# 2 Type of business .71	
		# 13 End user = individual -.78	
		# 14 End user = manufacturer .59	
		# 18 Number of end users -.64	
		# 20 Concentration of purchases of end users -.73	
		# 26 Purchase frequency of end users -.56	
		# 34 Channels of distribution go direct to end users .72	
		# 37 Channels of distribution to retailers -.76	
		# 38 Gross margin earned on this busi- ness's products by channels of distribution -.67	
+	5	Personal selling	.047
		# 19 Number of immediate customers .57	
		# 29 Purchase amount-immediate customers -.57	
		#127 Gross margin/revenue .51	
		#147 Sales force expense/revenue .74	
		#162 Marketing expense/revenue .67	
		#251 Sales/salesman -.74	
-	13	Profitability	.020
		#127 Gross margin/revenue .57	
		#167 Net income/revenue .82	
		#263 Total cash flow/revenue	
+	29	End users = contractors	.020
		# 17 End users = contractors .78	
+	3	Capital intensity	.019
		# 92 % continuous process .53	
		#201 Gross book value/revenue .86	
		#206 Net book value/revenue .87	
		#255 Gross book value/employee .82	
		#345 Gross book value/standard capacity .81	
-	9	Customer purchase frequency	.019
		# 26 Purchase frequency of end users .52	
		# 27 Purchase frequency of immediate customers .69	
		# 28 Amount purchased by end users .53	
		# 36 Channels of distribution to wholesalers -.67	
+	40	Internal channels of distribution	.019
		# 35 Internal channels of distribution to retailers .69	
+	18	Relative marketing intensity	.012
		#314 Relative sales force expense .76	
		#318 Relative media advertising expense .74	
		#322 Relative promotion expense	

Raw Material Plus Work-in-Process Inventory/Revenue

Sign of Factor in Regression	Factor #	Factor Name and Highest Loading PIMS Variable	Contribution to R ²
+	14	Production method	.062
		# 90 % of sales made in small batches .77	
		# 91 % of sales made on assembly line -.76	
-	13	Profitability	.047
		#127 Gross margin/revenue .57	
		#167 Net income/revenue .82	
		#263 Total cash flow/revenue .57	
-	3	Capital intensity	.035
		# 92 % continuous process .53	
		#201 Gross book value/revenue .86	
		#206 Net book value/revenue .87	
		#255 Gross book value/employee .82	
		#345 Gross book value/standard capacity .81	
-	8	Absolute advertising and promotion expense	.034
		#152 Advertising and promotion expense/revenue .81	
		#157 Advertising media expense/revenue .83	
		#162 Marketing expense/revenue .54	
+	6	In-house production-vertical integration	.028
		#102 Purchases/revenue -.68	
		#107 Value added/revenue .69	
		#117 Manufacturing expense/revenue .88	
		#122 Manufacturing plus depreciation expense/revenue .88	
		#239 Sales/employee -.63	
+	24	Net exports	.026
		# 83 % of industry sales contributed by exports .69	
		#334 % industry sales contributed by exports minus the % contributed by imports .87	
+	19	Externally imposed constraints	.018
		# 54 Government price controls -.52	
		# 64 Inventory accounting method .56	
		# 68 Location of market served .65	
+	16	Market share instability	.015
		#335 Sum of market share changes .74	
		#374 Your share instability .72	
		#375 Total share instability .78	
-	10	Reputation for quality and service	.014
		#286 % superior quality products minus % inferior quality products .66	
		#290 Relative price of product(s) .55	
		#326 Relative customer service .68	
		#330 Relative image of product and company .76	
+	32	Price-cost margin	.012
		#341 Weighted price growth minus weighted cost growth	

APPENDIX C

Results of Testing Working Capital Hypotheses

Hypothesis 1: Industry instability

Testing over both time periods provided strong support for the hypothesis that the greater the long term variability of industry sales, the lower the level of working capital/revenue, with working capital/revenue decreasing at a decreasing rate at higher levels of industry sales variability.

Hypothesis 2: Media induced brand loyalty

Testing over both time periods provided strong support for the hypothesis that the greater the degree media advertising the lower the level of working capital/revenue.

Hypothesis 3: Reputation for service and quality

Testing over both time periods provided strong support for the hypothesis that the better a business's product image and company reputation the lower the level of working capital/revenue decreasing at a decreasing rate for businesses with best product images.

Hypothesis 4: Selling pressure

Testing over both time periods provided strong support for the hypothesis that the greater the selling pressure exerted internally by salesmen or externally by a business's channels of distribution, the greater the level of working capital/revenue. While three of the four variables used to test this hypothesis were found in both time periods to be significant and to have the expected sign, the purchase frequency--immediate customers variable did not have the expected sign during the 1974-77 period. A brief discussion of the possible cause for this occurrence follows:

Purchase frequency--immediate customers squared. The expected sign of this variable was positive, yet the actual sign was significantly negative during the 1974-77 period. The level of interest rates was significantly higher in the 1974-77 period than in the 1970-73 period. The increase in the cost of capital during the 1974-77 period is, therefore, thought to have caused businesses to reduce their willingness to use the extension of credit as a means of maintaining strong personal relationships with customers. The resulting lower level of accounts receivable/revenue is thought to be responsible for the increase of working capital/revenue at a decreasing rather

than an increasing rate as the purchase frequency of a business's customers declines. Since the coefficient of the squared term was appreciably less than that of its unsquared form, the squared term's impact rivals that of its level only for substantial deviations from the mean.

Hypothesis 5: Supply

Testing over both time periods provided strong support for the hypothesis that the more stable or dependable the sources of supply, the lower the level of working capital/revenue.

Hypothesis 6: Product demand

Testing provided strong support for the hypothesis that the greater the demand for a business's product(s), the lower the level of working capital/revenue, in the first time period, and moderate support in the second time period.

Hypothesis 7: Wage rate growth

Testing over both time periods provided strong support for the hypothesis that the greater the growth of a business's wage rates, the greater the level of working capital/revenue.

Hypothesis 8: Industry exports

Testing provided strong support for the hypothesis that the greater the percentage of sales exported by a business's S.I.C. group, the greater the level of working capital/revenue, in the first time period, and moderate support in the second time period. While the linear form of the industry exports variable was found to be significant and to have the expected sign, the industry exports squared variable did not have the expected sign during the 1974-77 period. A brief discussion of the possible cause for this occurrence follows.

Industry exports squared. The expected sign of this variable was negative, yet the actual sign was significantly positive during the 1974-77 period. From 1975-77, the U.S. experienced a large increase in the trade deficit of industrial supplies due at least in part to the increases in oil prices, as well as to significantly increased industrial production from some non-oil developing countries (Brazil, Mexico, Taiwan, and Singapore). The increased competition from these non-oil developing countries is thought to have caused businesses which export to increase their use of accounts receivable and finished goods as selling tools, in an effort to maintain their market position. The resulting higher levels of

working capital for businesses in export oriented industries is thought to be responsible for the increase of working capital/revenue at an increasing rate, rather than at a decreasing rate, during the 1974-77 period. Since the coefficient of the squared term was appreciably less than that of its unsquared form, the squared term's impact rivals that of its level only for substantial deviations from the mean.

Results of Testing Accounts Receivable Hypotheses

Hypothesis 1: Price effects

Testing in both time periods provided strong support for the hypothesis that the greater a business's selling price relative to the competition, the greater the level of accounts receivable/revenue. Support for the hypothesis that the greater the forecasted increase in selling price the greater the level of accounts receivable was moderate in the first time period and strong in the second time period.

Hypothesis 2: Market share instability

Testing over both time periods provided strong support for the hypothesis that the greater the instability in a business's market share, the greater the level of accounts receivable/revenue.

Hypothesis 3: Gross margin

Testing over both time periods provided strong support for the hypothesis that the greater a business's gross margin, the greater the level of accounts receivable/revenue. While four of the five variables used to test this hypothesis were found in both time periods to be significant and to have the expected sign, the industry concentration squared variable did not have the expected sign during the 1974-77 period. A brief discussion of the possible cause for this occurrence follows.

Industry concentration ratio squared. The expected sign of this variable was positive, yet the actual sign, while not highly significant, was negative during the 1974-77 period. The level of interest rates was significantly higher in the 1974-77 period than in the 1970-73 period. The increase in cost of capital is, therefore, thought to have caused businesses in concentrated industries to cut back on the use of liberal credit as a form of non-price competition. The resulting lower level of accounts receivable/revenue is thought to be responsible for accounts receivable increasing at a decreasing rather than at an increasing rate as the industry concentration ratio increases. Since the coefficient of the squared term was appreciably less than that of its unsquared term, the squared term's impact rivals that of its level only for substantial deviations from the mean.

Hypothesis 4: Selling pressure

Testing over both time periods provided strong support for the hypothesis that the greater the influence of the selling group within a business the greater the level of accounts receivable/revenue.

Hypothesis 5: Brand loyalty

Testing over both time periods provided strong support for the hypothesis that the greater the use of media advertising and other promotional efforts, the less the need to use accounts receivable/revenue as a selling tool and the lower the level of accounts receivable/revenue.

Hypothesis 6: Personalized customer relationships

Testing over both time periods provided moderate support for the hypothesis that the more personalized a business's relationship with its customers, the greater will be the level of accounts receivable/revenue. While the standardization variable used to test this hypothesis was found to have the expected sign in both time periods, the purchase frequency--immediate customers variable did not have the expected sign during the 1974-77 period. A brief discussion of the possible cause for this occurrence follows.

Purchase frequency--immediate customers. The expected sign of this variable was positive, yet the actual sign, while not highly significant, was negative. The level of interest rates was significantly higher in the 1974-77 period than in the 1970-73 period. The increase in the cost of capital during the 1974-77 period is, therefore, thought to have caused businesses to rely less upon the extension of credit as a means of maintaining strong personal relationships with customers. The resulting decrease in the level of accounts receivable is thought to be responsible for the weak negative relationship between accounts receivable/revenue and purchase frequency--immediate customers during the 1974-77 period.

Hypothesis 7: Product demand

Testing over both time periods provided moderate support for the hypothesis that the stronger the bargaining position of the seller, the lower the level of accounts receivable/revenue.

Hypothesis 8: Industry instability

Testing over both time periods provided strong support for the hypothesis that the greater the long term variability of industry sales, the lower the level of accounts receivable/revenue, with accounts receivable/revenue decreasing at a decreasing rate at higher levels of sales variability.

Hypothesis 9: Industry exports

Testing over both time periods provided strong support for the hypothesis that the greater the percentage of sales exported by a business's S.I.C. group, the greater the level of accounts receivable/revenue.

Hypothesis 10: Process research and development

Testing over both time periods provided strong support for the hypothesis that the greater the percentage that process research and development expenses are of a business's sales, the lower the level of accounts receivable/revenue.

Hypothesis 11: Capacity utilization

Testing over both time periods provided strong support for the hypothesis that the greater a business's capacity utilization, the greater the level of accounts receivable/revenue.

Results of Testing Finished Goods Inventory Hypotheses

Hypothesis 1: Standardization

Testing over both time periods provided strong support for the hypothesis that the more "tailor made" the product, the lower the level of finished goods inventory/revenue.

Hypothesis 2: Capital intensity

Testing over both time periods provided strong support for the hypothesis that the more capital intensive the production process, the greater the level of finished goods inventory/revenue.

Hypothesis 3: Selling pressure

Testing over both time periods provided strong support for the hypothesis that the greater the extent to which sales considerations influence a business, the greater will be the level of finished goods inventory/revenue. While two of the three variables used to test this hypothesis were found in both time periods to be significant and to have the expected sign, the gross margin to channels squared variable did not have the expected sign in the 1970-73 period. A brief discussion of the possible cause for this occurrence follows.

Gross margin to channels squared. The expected sign of the variable was negative, yet the actual sign, while not highly significant, was positive during the 1970-73 period. The rate of inflation was significantly greater in the 1974-77 period than in the 1970-73 period. Given the lower relative rate of inflation in the 1970-73 period, it is felt that the gross margin earned by channels of distribution was higher in the 1970-73 period relative to the 1974-77 period. The relatively higher gross margin of channels of distribution is thought to have been responsible for creating additional pressures to ship quickly, which led to the increase in finished goods inventory/revenue at a slightly increasing rate than at a decreasing rate. Since the coefficient of the squared term was appreciably less than that of its unsquared form, the squared term's impact rivals that of its level only for substantial deviations from the mean.

Hypothesis 4: Brand loyalty

Testing over both time periods provided strong support for the hypothesis that the greater the degree of customer brand loyalty, the lower the level of finished goods inventory/revenue.

Hypothesis 5: Non-price competition

Support for the hypothesis that the greater the competitive pressure in the form of suppliers integrated forward, the greater the level of finished goods inventory/revenue was strong during the first time period and moderate during the second time period.

Testing over both time periods provided strong support for the hypothesis that the greater the competitive pressure from imports, the greater the level of finished goods inventory/revenue.

Hypothesis 6: Real sales growth

Testing over both time periods provided strong support for the hypothesis that the greater a business's real sales growth, the lower the level of finished goods inventory/revenue.

Hypothesis 7: Industry instability

Testing over both time periods provided strong support for the hypothesis that the greater the long term variability of industry sales, the lower the level of finished goods inventory/revenue, and moderate support for finished goods inventory/revenue decreasing at a decreasing rate at higher levels of industry sales variability.

Hypothesis 8: Development time for new products

Testing over both time periods provided strong support for the hypothesis that the longer the time period necessary to develop new products, the lower the level of finished goods inventory/revenue, and no support for finished goods inventory/revenue decreasing at a decreasing rate with increases in development time.

Results of Testing Raw Material Plus Work-in-Process Inventory Hypotheses

Hypothesis 1: Supply

Testing over both time periods for the hypothesis that the less stable or dependable the source(s) of supply, the greater the level of raw material plus work-in-process inventory/revenue.

Hypothesis 2: Standardization

Testing over both time periods provided strong support for the hypothesis that the less standardized or more "made to order" the product, the greater the level of raw material plus work-in-process inventory/revenue.

Hypothesis 3: New product production

Testing over both time periods provided strong support for the hypothesis that the greater the degree of new product production, the greater the level of raw material plus work-in-process inventory/revenue.

Hypothesis 4: Product line breadth

Testing over both time periods was not supportive of the hypothesis that the greater the breadth of a business's product line, the greater the level of raw material plus work-in-process inventory/revenue.

Hypothesis 5: Capacity utilization

Testing over both time periods provided strong support for the hypothesis that the greater a business's capacity utilization, the lower the level of raw material plus work-in-process inventory/revenue.

Hypothesis 6: Competition

Testing over both time periods was supportive of the hypothesis that the greater the competition in a business's served market the lower the level of raw material plus work-in-process inventory/revenue.

Hypothesis 7: Selling pressure

Testing over both time periods provided strong support for the hypothesis that the greater the pressure to ship the end product quickly and in adequate quantity, the greater the level of raw material plus work-in-process inventory/revenue.

Hypothesis 8: Industry exports

Testing over both time periods provided strong support for the hypothesis that the greater the percentage of sales exported by a business's S.I.C. group, the greater the level of raw material plus work-in-process inventory/revenue.

Hypothesis 9: Direct costs

Testing over both time periods provided strong support for the hypothesis that the greater the proportion that purchases and manufacturing labor and overhead are of total cost, the greater will be the level of raw material plus work-in-process inventory/revenue.