

**THE ASSOCIATION BETWEEN WORKING CAPITAL MEASURES  
AND THE RETURNS OF SOUTH AFRICAN INDUSTRIAL FIRMS**

by

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PRO DEO GLORIA

**dedicated to Andrea, Marc and Dylan**

**ABSTRACT**

This study investigates the association between traditional and alternative working capital measures and the returns of industrial firms listed on the Johannesburg Stock Exchange. Twenty five variables for all industrial firms listed for the most recent 10 years were derived from standardised annual balance sheet data of the University of Pretoria's Bureau of Financial Analysis. Traditional liquidity ratios measuring working capital position, activity and leverage, and alternative liquidity measures, were calculated for each of the 135 participating firms for the 10 years. These working capital measures were tested for association with five return measures for every firm over the same period.

This was done by means of a chi-square test for association, followed by stepwise multiple regression undertaken to quantify the underlying structural relationships between the return measures and the working capital measures. The results of the tests indicated that the traditional working capital leverage measures, in particular, total current liabilities divided by funds flow, and to a lesser extent, long-term loan capital divided by net working capital, displayed the greatest associations, and explained the majority of the variance in the return measures.

A t-test, undertaken to analyse the size effect on the working capital measures employed by the participating firms, compared firms according to total assets. The results revealed significant differences between the means of the top quartile of firms and the bottom quartile, for eight of the 13 working capital measures included in the study. A nonparametric test was applied to evaluate the sector effect on the working capital measures employed by the participating firms. The rank scores indicated significant differences in the means across the sectors for six of the 13 working capital measures.

A decrease in the working capital leverage measures of current liabilities divided by funds flow, and long-term loan capital divided by net working capital, should signal an increase in returns, and vice versa. It is recommended that financial managers consider these findings when forecasting firm returns.

**KEY WORDS**

**value of corporate liquidity**  
**traditional liquidity measures**  
**alternative liquidity measures**  
**chi-square associations**  
**stepwise regression models**  
**size t-tests**  
**Kruskal-Wallis sector tests**  
**working capital components**  
**listed industrial firms**  
**liquidity/return association**

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Brealey and Myers (1991:918) regard *the value of corporate liquidity* as one of the "10 unsolved problems (in finance) that seem ripe for productive research".

## PART I

### INTRODUCTION AND OUTLINE OF STUDY

## CHAPTER 1

### INTRODUCTION AND BACKGROUND

#### 1.1 BACKGROUND

Brealey and Myers (1991:675) approach the complex field of financial management by dividing the financial manager's task into a series of narrowly defined themes, subordinate to the major themes of long-term and short-term decision making. In this way, a pragmatic method of dealing with many diverse and multifaceted duties is advocated, whilst considering the combined effects of these decisions on the firm in its entirety.

Long-term financial decisions involve capital budgeting, cost of capital, the management of capital structure and dividend policy. Much theory and research have been developed in these areas of financial management, for example the development of the capital asset pricing model, the arbitrage pricing theory, risk measures in capital budgeting, efficient markets hypothesis, derivatives and dividend relevance theory. Today, these and many other new long-term financial management concepts are being successfully employed in practice.

Short-term financial decisions are those relating to the management of working capital within the firm. The management of working capital includes the management of assets and liabilities such as cash, marketable securities, accounts receivable, inventory and accounts payable. The nature of these assets and liabilities dictates the vibrancy of the working capital management policy of the firm, with continuous monitoring of activities required, to which prompt and effective decision making needs to be applied. Hence these short-term decisions consume the majority of the financial manager's time, and are

regarded as the most important area of financial management in his or her day-to-day responsibilities (Beaumont 1991:74-76).

Common to all promoters of working capital theory is the general recognition that the two goals of working capital management should be the optimisation of the returns (or profitability), and the liquidity of the firm. The former goal is best defined in terms of shareholder wealth maximisation; the latter goal strives to ensure that a firm can meet its financial obligations as they fall due, and continue as a going concern. The two goals of working capital management are often in conflict, because the maximisation of the firm's returns could seriously threaten the liquidity and, conversely, the pursuit of liquidity tends to dilute returns. The solution lies in the optimal trade-off between returns on net current assets employed and the ability to pay current liabilities as they fall due, within the ambit of a clearly defined risk policy of which a firm's liquidity level should be a function (Pass & Pike 1984:1).

For many years analysts have applied traditional ratio analysis as a fundamental tool in the measurement of corporate liquidity. Well-recognised measures, such as the current and quick ratios, are a time-honoured, convenient way of classifying large amounts of financial data to compare firms' performance (Brealey & Myers 1991:675). Whilst the financial textbooks note the limitations of ratio analysis, namely that their usefulness is entirely dependent on skilful interpretation, these traditional measures of liquidity are further criticised for inconsistency in measurement, and for presenting myopic results. The chief censure is that the static nature of traditional ratios makes them unreliable for appropriate estimation of the operating cash flow, which ultimately determines the extent of liquidity of a firm<sup>1</sup>.

Some measures have recently been developed as possible alternatives for measuring corporate liquidity. Richards and Laughlin (1980:33), for example, developed the cash conversion cycle. Emery (1984:27) proposed a new liquidity index, Lambda, while Shulman and Dambolena (1986:35-36) applied the use of the net liquid balance as a

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1 See Beyer (1988:14); Emery (1984:25); Kamath (1989:24); Kelly (1982:44-49); Maness and Henderson (1989:19); Richards and Laughlin (1980:33); Shulman and Dambolena (1986:35); and Soenen (1993:53) in this regard.

measure of liquidity. Melnyk and Berati (Scherr 1989:357-372) developed the comprehensive liquidity index, a liquidity-weighted version of the current ratio, and Gentry, Vaidyanathan and Lee (1990:91) advocated the use of a weighted cash conversion cycle, measuring the weighted number of days funds are tied up in current assets and liabilities<sup>2</sup>.

Despite efforts to advance the body of knowledge regarding working capital management and its risk-return trade-off, this area of financial management lacks empirical confirmation of the normative theorems (Beranek 1988:12). In South Africa, there have been few local empirical studies on working capital behaviour (this aspect is addressed in sec 1.3 in more depth). A manifestation of the scarcity of research in this area is reflected in the results of a review of accredited journal publications in South Africa over the last 30 years, which found that working capital management had been represented by only four papers during this time, all of which were published prior to 1985 (Firer & Sandler 1994:7).

## 1.2 IMPORTANCE OF THE STUDY

A recent survey of the use of financial management techniques by South African manufacturers revealed that 81 percent of the respondents regarded working capital management as the most important area of financial management. Of the respondents, 87,5 percent used some type of cash and debtor management practice, and 82 percent made use of inventory management practices. Furthermore, the financial decision makers of the firms surveyed devoted most of their time to working capital management decisions<sup>3</sup>.

An analysis was made of the totals of long-term and short-term assets and liabilities of the *Financial Mail's* (June 1994) top 100 industrial firms according to asset holdings. The statistics for the first 33 companies on the listing were derived from the database of the Bureau of Financial Analysis (or BFA) at the University of Pretoria, the results of

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2 Section 4.3.3 discusses these alternative liquidity measures in detail.

3 See Beaumont (1991:74-76).

TABLE 1.1  
EXTRACT OF FINANCIAL STATISTICS FROM THE BFA DATABASE

| Company       | Total assets (R000) | Current assets (R000) | CA % TA | Total liabilities (R000) | Current liabilities (R000) | CL % TL |
|---------------|---------------------|-----------------------|---------|--------------------------|----------------------------|---------|
| Barlows       | 28 884              | 13 106                | 45      | 10 960                   | 8 197                      | 75      |
| SA Breweries  | 15 202              | 7 201                 | 47      | 8 336                    | 5 800                      | 70      |
| Sasol         | 11 926              | 3 407                 | 29      | 5 055                    | 2 534                      | 50      |
| CG Smith      | 10 813              | 6 156                 | 57      | 5 196                    | 4 340                      | 84      |
| Iscor         | 9 954               | 3 563                 | 36      | 3 323                    | 1 562                      | 47      |
| Amic          | 11 384              | 3 950                 | 35      | 4 189                    | 2 643                      | 63      |
| Sappi         | 8 907               | 1 950                 | 22      | 3 360                    | 1 820                      | 54      |
| Remgro        | 7 479               | 1 647                 | 22      | 993                      | 848                        | 85      |
| ICS Foods     | 7 778               | 4 500                 | 58      | 3 984                    | 3 203                      | 80      |
| Safren        | 6 808               | 1 633                 | 24      | 3 195                    | 1 726                      | 54      |
| Malbak        | 6 572               | 4 523                 | 69      | 2 847                    | 2 687                      | 94      |
| Engen         | 6 444               | 2 266                 | 35      | 3 513                    | 2 149                      | 61      |
| Tiger Oats    | 5 020               | 3 105                 | 62      | 2 570                    | 2 010                      | 78      |
| AVI           | 4 946               | 3 476                 | 70      | 2 209                    | 1 653                      | 75      |
| M&R Holdings  | 4 600               | 2 367                 | 52      | 2 261                    | 1 590                      | 70      |
| AECI          | 4 491               | 2 415                 | 54      | 2 176                    | 1 438                      | 66      |
| Premier Group | 3 645               | 1 988                 | 55      | 2 024                    | 1 838                      | 91      |
| Kersaf        | 3 479               | 505                   | 7       | 1 189                    | 741                        | 62      |
| Tongaat       | 3 120               | 1 301                 | 42      | 1 037                    | 749                        | 72      |
| W & A         | 2 261               | 1 002                 | 44      | 1 938                    | 793                        | 41      |
| Pepkor        | 2 623               | 1 823                 | 70      | 1 851                    | 1 435                      | 78      |
| Nampak        | 2 608               | 1 383                 | 53      | 1 074                    | 1 002                      | 93      |
| Hiveld        | 2 477               | 991                   | 40      | 885                      | 609                        | 69      |
| Sentrachem    | 2 162               | 1 268                 | 59      | 1 256                    | 896                        | 71      |
| Anglo Alpha   | 2 052               | 415                   | 20      | 409                      | 284                        | 69      |
| SunBop        | 2 014               | 140                   | 7       | 718                      | 364                        | 51      |
| Toyota        | 2 135               | 1 185                 | 56      | 839                      | 499                        | 60      |
| Metkor        | 1 927               | 1 023                 | 53      | 965                      | 818                        | 85      |
| Wooltru       | 1 839               | 866                   | 47      | 963                      | 819                        | 85      |
| Altron        | 1 808               | 1 192                 | 66      | 686                      | 678                        | 99      |
| Dorbyl        | 1 727               | 932                   | 54      | 873                      | 730                        | 84      |
| Edgars        | 1 668               | 1 405                 | 84      | 969                      | 741                        | 76      |
| Plate Glass   | 1 625               | 978                   | 60      | 1 033                    | 969                        | 94      |
| Average       |                     |                       | 46      |                          |                            | 72      |

Source: BFA database

which are summarised in table 1.1. Observations from table 1.1 are that the current assets as a percentage of total assets (CA % TA column) vary between seven percent for Kersaf and Sunbop, and 84 percent for Edgars. The average value of this ratio for the 33 firms is 46 percent. This percentage is very close to a previous analysis of current assets to total assets held by a sample of South African manufacturers over the period 1968 to 1982 which showed that, on average, 47 percent of total assets were held in the form of current assets<sup>4</sup>. Similarly, the current liabilities as a percentage of total liabilities (CL % TL column) vary between 41 percent for W & A and 99 percent for Altron. The average value of this ratio for the 33 firms is 72 percent. Even to the casual observer then, these figures in table 1.1 accentuate the importance of working capital management as a research area in financial management.

### 1.3 RESEARCH PROBLEM

The aim of this section is to formulate the research problem. The research problem stems from prior research concerning the relationship between working capital and the returns of firms. For this reason a brief discussion of relevant research is forwarded before proceeding to the research problem.

Research in the area of working capital theory has received far less attention than other topics of financial management. Evidence of this is presented by Beranek (1988:12), Cohn and Pringle (1980:35), Gamble (1988:36), Harris (1975:1), Pass and Pike (1987:18), Smith (1988:18, 609), Stowe, Vadakkepat and Willoughby (1984:1) and Van Horne (1980:535).

Researchers such as Walker, Van Horne, Cohn and Pringle and Beranek attempted to develop theories of working capital aimed at providing guidelines for healthy financial management practices. Their findings will now be briefly discussed with a view to deriving the research problem, objectives and hypotheses of this study. The findings of researchers abroad will be discussed, followed by an enumeration of local research undertaken.

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4 See Penning (1985:335).

### 1.3.1 Research done abroad

#### 1.3.1.1 *The findings of Walker*

Walker's theory of working capital states that the opportunity for gain or loss varies directly in relation to the amount of risk that management are willing to assume (Harris 1975: 5-8). This theory is based on the following propositions:

- \* If the amount of working capital is varied relative to fixed capital, the risk that a firm is willing to assume is also varied, thereby increasing the opportunity for gain or loss.
- \* The type of capital used to finance working capital will directly affect the amount of risk assumed by the firm and its opportunity for gain or loss.
- \* The greater the disparity between the maturity of the debt instruments of a firm and its flow of internally generated funds, the greater the risk is.

#### 1.3.1.2 *The findings of Harris*

The interrelationships of working capital, return on investment, and risk were investigated by Harris (1975:5-8) according to the first principle of Walker's theory, (viz if working capital is varied relative to sales, the amount of risk that a firm assumes is also varied and the opportunity for gain or loss is increased) and two related corollaries. The two corollaries tested were firstly, in certain industries, aggressive working capital policies affect profit more readily than in other industries, and secondly, differences in asset size create different relationships between working capital and profit.

Harris's research revealed a significant relationship between working capital turnover and return on investment, in support of Walker's first proposition, but did not confirm the thesis that a chance for gain or loss is present when working capital turnover is high. The correlation tests performed on the two related corollaries did not demonstrate any differences by industry or by asset size as related to a relationship between return on investment and working capital turnover.

### **1.3.1.3**      *The findings of Van Horne*

Van Horne (1980:535) proposed a model to analyse the risk-return trade-off for different levels of liquid assets held by a firm, and different maturity compositions of its debt. The major input to his model was the use of a cash budget, to which certain probability concepts could be applied. In this way, the risk of running out of cash for various levels of liquid assets and different debt compositions could be realistically appraised. Thus by taking into account the opportunity cost of a change in liquid assets and/or the maturity composition of the debt, the trade-off between profitability and risk could be evaluated. In this way, management would be provided with information to make a decision on the level of current assets and liabilities to be held. This decision would nevertheless ultimately depend on the risk preferences of the firm's management.

### **1.3.1.4**      *The findings of Beranek*

According to Scherr (1989:3), Beranek first developed the elements of working capital under perfect product and capital markets, thereafter introducing the element of uncertainty, and finally considering imperfect product and capital markets. Numerous implications were derived in the conclusion of the paper, some stemming from the financial explanations of trade credit, others from explanations regarding transactions costs, and yet others from further numerous possibly relevant conditions. One could conclude from the paper that in a perfect world there would be no need for holding working capital assets and liabilities. However, the characteristic of uncertainty (risk) which is very prevalent in real-world circumstances, poses threats and opportunities which a firm can address by implementing a strategy of working capital management that will deal with the issue of risk, whilst maximising the benefit for the shareholders of the firm.

### **1.3.1.5**      *The findings of Smith*

Smith (1980:549) addressed the returns versus liquidity trade-off by suggesting the use of parallel monthly forecasts to estimate the impact of certain working capital policies on the goals of the firm and to reflect the inherent uncertainty of the future. Depending on

the quality and reliability of the input information on which the parallel forecasts of returns and liquidity would be based, the forecasts could provide a framework in which management might examine the effects of future actions or policies on the financial wellbeing of the firm.

#### **1.3.1.6        *The findings of Kamath***

More recently, Kamath (1989:24-28), using Spearman's rank correlation technique, reported on correlation coefficients between operating profits divided by total assets and the working capital liquidity measures of current ratio, quick ratio, cash conversion cycle and net trade cycle. He found that the last two liquidity measures displayed the expected negative correlation with the return measure. He also tested whether the current and quick ratios would produce similar rankings to the cash conversion cycle for retail grocery firms. His findings did not reveal such a relationship.

#### **1.3.1.7        *The findings of Soenen***

Following on Kamath's research, a study examining the association between the net trade cycle and total return on total assets (Soenen 1993:53-57) employed chi-square two-way tables to study the relationship between the working capital measure and firm returns. The results of the research showed evidence of a negative relationship between the working capital measure and returns, although significant for only nine of the twenty industries included in the research.

### **1.3.2    Local research**

#### **1.3.2.1        *The findings of Singh***

This study researched the trend of the current ratio in certain South African industries, and recommended that the liquidity of a firm should be evaluated in terms of cash inflows and outflows, rather than strictly according to the traditional current ratio method (Singh 1987:99). Singh remarked that a difficulty with the current ratio as a measure of liquidity stemmed from the fact that it was a dual-purpose measure; it simultaneously measured

the liquidity and profitability of a firm. He proposed two alternate measures of liquidity, namely cash flow to current debt minus accounts payable, and cash on hand plus cash flow to current debt minus accounts payable.

#### **1.3.2.2        *The findings of Penning***

A study undertaken by Penning (1985:335) on the management of current assets in South African manufacturers concentrated on quantitative and financial aspects, and found that where the composition of the current assets of a firm varied within certain parameters, the profitability and risk of the firm were not markedly affected.

#### **1.3.2.3        *Other local research***

Other South African studies concentrated on specialised areas of working capital, such as debtors (Ferreira 1981), cash (Galbraith 1977; Klerck & Birkholtz 1984; Leimecke 1988) or working capital financing (Nairn 1973; Venter 1989; Visser 1988). Still other studies were undertaken with reference to a specific industry, for example, men's retail clothing industry (Buhr 1992), retail pharmacies (Meyer 1989), construction material industry (Church 1979) small business (Roos 1987) and medium-sized manufacturers (Field 1979).

#### **1.3.3    The research problem**

Local studies on working capital management have generally concentrated on a specific aspect of the financial discipline, or the management of working capital within a particular industry.

No previous studies in South Africa have focused on the association between working capital measures and accounting returns. This study has the unique research problem of determining associations between traditional and alternative working capital measures of liquidity and the returns of South African industrial firms. In this way, the study will attempt to ascertain and describe relationships between the liquidity and return measures identified in the literature study.

#### 1.4 OBJECTIVE OF THE STUDY

The objective of the study is to investigate and describe the association between traditional and alternative working capital measures and the returns of South African industrial firms.

#### 1.5 RESEARCH HYPOTHESES

Ryan, Scapens and Theobald (1992:99) describe a research hypothesis as a statement of an empirical relationship between a set of variables.

The research hypotheses for this study are as follows:

- \* The traditional and alternative working capital measures of South African listed industrial firms associate differently with firm returns.
- \* There is a significant size effect on the working capital measures employed by South African listed industrial firms.
- \* There is a significant sector effect on the working capital measures employed by South African listed industrial firms.

#### 1.6 GOALS OF THE STUDY

The overall objective of the study, namely the investigation of the association between working capital measures and the returns of South African listed industrial firms, can be subdivided into the following goals:

- \* to provide, through the study of the literature, a theoretical overview of working capital management
- \* to examine the components of working capital as described by the literature

- \* to identify traditional and alternative working capital measures of liquidity, and to identify recognised measures of return
- \* to describe the methodology used to investigate the association between traditional and alternative working capital measures of liquidity and the returns of South African listed industrial firms
- \* to test the three hypotheses of the study by employing appropriate statistical techniques
- \* to describe the results and findings of the research.

## 1.7 METHOD OF RESEARCH

In order to attain the goals of the study, the following research method was followed:

- \* A exhaustive study of the relevant literature was undertaken with the following intentions in mind. Firstly, an overview of working capital management was presented, and some insight gained into its components. Thereafter, working capital measures were identified and discussed in terms of traditional and alternative liquidity measures. Recognised measures of return were also identified. The purpose of the literature study was to provide a suitable framework of existing knowledge to serve as a departure point for the empirical study.
- \* Secondary annual data for all industrial firms listed on the Johannesburg Stock Exchange (JSE) for 10 years were extracted from the databank of the Bureau of Financial Analysis.
- \* The three hypotheses were tested by means of the statistical techniques of chi-square for association, multiple regression, t-tests, and nonparametric rank correlation tests.
- \* Results, findings and recommendations based on the empirical evidence of the

research form the conclusion to the study.

## 1.8 LIMITATIONS OF THE STUDY

The limitations of the study are the following:

- \* The choice of measures used in the empirical study was reliant on the availability of the data acquired from the Bureau of Financial Analysis. Annual balance sheet and income statement data from industrial firms listed on the Johannesburg Stock Exchange for the most recent ten years formed the basis of the calculations needed to perform the analysis.
- \* In the data classification and analysis, there had to be a ceiling on the volume of variables chosen, in order to limit the scope of the study in terms of statistical testing.

## 1.9 OUTLINE OF THE STUDY

The study comprises three parts.

Part I introduces the topic and states the overall objective, hypotheses and goals of the research. The importance of the study and its limitations are also covered.

Part II deals with the literature study on which the empirical research will be focused. It consists of chapters 2, 3 and 4. Chapter 2 provides an overview of working capital management, chapter 3 delineates and describes the components of working capital, and chapter 4 defines working capital measures in terms of traditional and alternative liquidity measures, and examines recognised measures of return.

Part III deals with the empirical study and consists of chapters 5, 6 and 7. Chapter 5 describes the research methodology, with particular reference to the exploratory data analysis undertaken in the investigation of the association between traditional and alternative working capital measures and the returns of South African listed industrial

firms. In chapter 6, the three research hypotheses are addressed by applying the appropriate statistical procedures, in order to accept or reject the research hypotheses. The results of the various statistical tests are enumerated and analysed here. Chapter 7 concludes the study by discussing the findings of the research and making recommendations regarding possible future research areas.

PART II

LITERATURE STUDY

## CHAPTER 2

### OVERVIEW OF WORKING CAPITAL

#### 2.1 INTRODUCTION

The purpose of the literature study is to build a foundation of reference based on existing knowledge to serve as departure point for the empirical study. This is done by commencing with a global view of working capital management, followed by an examination of firstly the components of working capital, and thereafter the measures of liquidity and return that are to be used in the empirical study to follow in part III.

Chapter 2, the first of the three chapters constituting the literature study, has the specific purpose of attaining the first goal of the study, namely to provide a theoretical overview of working capital management. In order to place working capital management in proper perspective alongside other decision-making areas of the finance function, it is useful to trace the historical evolution of the concept. An insight into the nature of working capital necessitates the clarification of definitions and terminology at this point. Of particular importance here are the concepts of working capital policy and the need for working capital.

#### 2.2 THE HISTORICAL EVOLUTION OF WORKING CAPITAL MANAGEMENT

The historical evolution of working capital management can be traced back to references by early economists to the working capital concept, in particular, Adam Smith, a pragmatist, who distinguished between 'circulating' and 'fixed' capital (O'Donnell 1990:162-163). This 'circulating' capital concept was further promoted by writers such

as Ricardo, Mill and Marshall, although working capital did not emerge as an established body of fundamental erudition among their evolving theories of the firm (Beranek 1988:3-5).

The evolution of the subject working capital management probably originated in different accounting practices - for one, the budget. Cash budgets, for instance, forced management to pay attention to the timing and magnitude of cash flows, which, in turn, gave rise to short-term financial forecasting. Equally important was the promotion of the idea of controls in the accounting function, which led to the need to monitor all flows, resulting in the development of operating budgets. These operating budgets have since become strong resource allocation and working capital decision-making tools.

The accounting concept of funds flow analysis, or statement of source and application of funds, was a further contribution to working capital management. Interestingly, a suitable precise definition of 'funds' has yet to be agreed upon, although in the United States the designation in use is 'statement of changes in financial position' (Kelly 1982:3). To some managers, 'funds' means cash, while to others it represents financing, and to others still, it is working capital (Smith 1979:2-3). The pro forma financial statements emerged from the funds flow analysis, which enabled management to monitor the effect of working capital policies on projected income statements and balance sheets.

With the practice of the auditing of financial reports, independent accountants began to report to management and shareholders on issues such as adequacy of reserves for accounts receivable and calibre of inventory holdings. The use of financial ratios gained momentum, and the current ratio and acid test ratio became widely recognised measures of working capital adequacy. In the early twentieth century, heuristic criteria in the form of financial ratio tests and constraints started gaining acceptance. This heralded the advent of industry norms for current and acid test ratios, and accounts receivable and inventory turnover ratios. At the same time economists started to devote more attention to working capital. An example of this was Keynes (1936:168), who concentrated on the role of liquidity in the functioning of the economy and expounded on his renowned transactions, precautionary and speculative motives for holding cash.

Inventory planning models were encouraged by developments in operations research. As early as 1952, the United States Air Force had developed and implemented a simple system for repetitive purchases of nonrepairable weapon spares, which became known as the economic order quantity, or EOQ (Austin 1980:365). The appearance of the economic order quantity model led Baumol (1952:545-556) to build on its underlying logic to compute optimum cash balances. Further significant progress in operations research after World War II resulted in the advancement of the application of mathematical programming to numerous aspects of working capital management, and computer simulation of complex working capital problems became more feasible. Greater numbers of studies were able to use more quantitative methodology, and various models were designed to assist firms in handling their 'circulating capital' (Harris 1975:38).

A number of suboptimum models began to emerge from the 1950s, involving the search for appropriate methods to calculate optimum cash, accounts receivable and inventory holdings. In these models, each current asset was optimised, to the exclusion of the other two, and the optimum amount of working capital to be held would be the total of the three suboptimum decisions on the individual current assets. Baumol (1952:545-546) and Miller and Orr (1966:413-435) reported on the optimum levels of cash holdings, which would produce the smallest combined costs of ordering, holding and running out of cash. Orgler, Eppen and Faima and Calman used linear programming to optimise the control of cash (Harris 1975:42-43). Archer (1966:1-14) also designed a quantitative cash management model that specified that cash balances should be equal to a constant multiplier of the standard deviation of the cash flows. A number of authors attempted to optimise the investment in accounts receivable, for example, Benishay, Mehta and Cyert, and Davidson and Thompson (Harris 1975:44). However, accounts receivable received far less attention than cash.

Developments in the late 1970s and early 1980s led to increasing concern about the management of working capital. Firstly, the advent of historically high interest rates meant that the financing of investments in accounts receivable and inventories became costlier. Secondly, deregulated money markets gave financial managers access to numerous short-term investment and financing instruments (Scherr 1989:5). Also in the 1970s, business schools recognised that working capital management had finally attained

the credentials of a fully-fledged discipline in finance, and began to offer courses in working capital management. Today, finance textbooks treat topics on working capital as a matter of course (Beranek 1988:11), although coverage and depth on the subject vary from author to author.

## 2.3 DEFINITIONS ASSOCIATED WITH WORKING CAPITAL MANAGEMENT

The definitions associated with working capital management are now addressed, as an overall introduction to the subject, whilst affording perspicuity on the nature of working capital. To this end, the concepts of working capital management, net working capital, the working capital cycle, and permanent and seasonal working capital will receive attention.

### 2.3.1 Working capital management

Working capital management can be described as the management of short-term or current assets and liabilities, and their interrelationships, both with each other and with other balance sheet accounts. The short-term or current assets and liabilities of the firm are those items that can be converted into cash within a year (Hampton & Wagner 1989:4).

### 2.3.2 Net working capital

Net working capital is defined as the difference between current assets and current liabilities. The relationship between the current assets of typical South African industrial firms is reflected in the data presented in table 2.1. Current asset statistics were derived from the BFA database for the first 33 of the *Financial Mail's* (June 1994) top 100 industrial firms ranked according to asset holdings. Table 2.1 indicates that, on average, 39 percent of current assets are held in the form of inventories, 46 percent in the form of accounts receivable, and 15 percent in the form of cash. Accounts receivable and inventories constitute by far the largest rand investment in working capital, remembering that current assets (on average) constitute 46 percent of total assets held by these firms (see table 1.1).

Most firms in table 1.1 hold more current assets than current liabilities, reflecting a positive net working capital position. Since current liabilities represent the short-term funding of the firm, net working capital can be viewed as the portion of the firm's current assets that are financed with long-term funds (Gitman 1994:643).

TABLE 2.1  
EXTRACT OF FINANCIAL STATISTICS ON CURRENT ASSETS

| COMPANY       | CURRENT ASSETS | INVENTORIES (R000) | %  | RECEIVABLES (R000) | %  | CASH (R000) | %  |
|---------------|----------------|--------------------|----|--------------------|----|-------------|----|
| Barlows       | 13 106         | 5 264              | 40 | 4 885              | 37 | 2 957       | 23 |
| SA Breweries  | 7 201          | 2 570              | 36 | 4 541              | 63 | 90          | 1  |
| Sasol         | 3 407          | 1 129              | 33 | 1 378              | 40 | 900         | 27 |
| CG Smith      | 6 156          | 2 526              | 41 | 2 808              | 46 | 822         | 13 |
| Iscor         | 3 563          | 2 112              | 59 | 1 234              | 35 | 217         | 6  |
| Amic          | 3 950          | 1 312              | 33 | 1 634              | 41 | 1 004       | 26 |
| Sappi         | 1 950          | 763                | 39 | 1 098              | 56 | 89          | 5  |
| Remgro        | 1 647          | 854                | 52 | 277                | 17 | 516         | 31 |
| ICS Foods     | 4 500          | 1 778              | 40 | 2 040              | 45 | 682         | 15 |
| Safren        | 1 633          | 131                | 8  | 1 179              | 72 | 323         | 20 |
| Malbak        | 4 523          | 1 290              | 29 | 3 233              | 71 | 00          | 00 |
| Engen         | 2 266          | 742                | 33 | 1 198              | 53 | 326         | 14 |
| Tiger Oats    | 3 105          | 1 283              | 41 | 1 277              | 41 | 545         | 18 |
| AVI           | 3 476          | 1203               | 35 | 1 773              | 51 | 500         | 14 |
| M&R Holdings  | 2 367          | 1 171              | 49 | 916                | 39 | 280         | 12 |
| AECI          | 2 415          | 1 071              | 44 | 1 157              | 48 | 187         | 8  |
| Premier Group | 1 988          | 1 156              | 58 | 668                | 34 | 164         | 8  |
| Kersaf        | 505            | 90                 | 18 | 174                | 34 | 241         | 48 |
| Tongaat       | 1 301          | 439                | 34 | 604                | 46 | 258         | 20 |
| W & A         | 1 002          | 397                | 40 | 584                | 58 | 21          | 2  |
| Pepkor        | 1 823          | 1 119              | 61 | 332                | 18 | 372         | 21 |
| Nampak        | 1 383          | 654                | 47 | 640                | 46 | 89          | 7  |
| Hiveld        | 991            | 293                | 30 | 270                | 27 | 428         | 43 |
| Sentrachem    | 1 268          | 482                | 38 | 625                | 49 | 161         | 13 |
| Anglo Alpha   | 415            | 151                | 36 | 209                | 51 | 55          | 13 |
| SunBop        | 140            | 30                 | 21 | 64                 | 46 | 46          | 33 |
| Toyota        | 1 185          | 739                | 62 | 346                | 29 | 100         | 9  |
| Metkor        | 1 023          | 498                | 49 | 511                | 50 | 14          | 1  |
| Wooltru       | 866            | 334                | 38 | 499                | 58 | 33          | 4  |
| Altron        | 1 192          | 428                | 36 | 462                | 39 | 302         | 25 |
| Dorbyl        | 932            | 448                | 48 | 470                | 50 | 14          | 2  |
| Edgars        | 1 405          | 452                | 32 | 896                | 64 | 57          | 4  |
| Plate Glass   | 978            | 350                | 36 | 591                | 60 | 37          | 4  |
| Average       |                |                    | 39 |                    | 46 |             | 15 |

Source: BFA database

### 2.3.3 The working capital cycle

The working capital cycle is a reflection of the nature and interrelationships between current assets and liabilities. The value represented by working capital circulates among current assets and liabilities, a concept that can be logically traced back to Adam Smith's original 'circulating capital' concept (O'Donnell 1990:162-163).

Scherr (1989:4) projects the working capital cycle as exemplifying, to a large extent, the major flow of funds in terms of magnitude per annum, through an industrial firm engaged in manufacture. This cycle follows a typical pattern such as cash used to purchase labour and materials, which are used to produce inventory, which, when sold, becomes accounts receivable, which, on payment, are turned back into cash. Cash is pivotal to the flow of funds through the firm: as long as there is cash on hand, the firm will survive. But if it should happen that resources flow in more slowly, or even stop, the firm will be forced to take costly steps in the form of raising new funds or postponing capital expenditures or dividend payments in order to avoid a complete drain-out of resources.

One answer could be to hold a larger amount of cash on hand. However, cash is feasibly the least profitable asset of the firm, and holding large amounts of cash, although reducing the risk factor, also reduces the profitability of the firm. Scherr (1989:4), in fact, advocates that the 'working capital cycle is the lifeblood of the firm', and decisions on the management of working capital are a sensitive balance between minimising the risk of insolvency, whilst maximising the return on the assets employed to maintain liquidity.

### 2.3.4 Permanent and seasonal working capital

A distinction can be drawn between permanent and seasonal levels of working capital, even though the term 'working capital' refers to those current asset and liability accounts that can be converted into cash within a year. The reason for this distinction is the prevalence of the element of uncertainty in product demand and supply, which results in continuous fluctuations in the levels of working capital financing required for the successful operation of the firm.

More specifically, permanent levels of working capital can be described as those amounts of the various current assets and liabilities that are not influenced by weekly or monthly fluctuations in the firm's business activity, but are constantly rolled over and persist from year to year. They represent the minimum net working capital needed to carry on operations at any one time (Hampton & Wagner 1989:5).

Other current assets occur on a seasonal basis, and their funding requirements are irregular. Seasonal levels of working capital are the additional amounts needed at peak periods during the operating year. For example, increased levels of inventory are required to support sales during high-season demand; increased sales result in increased accounts receivable, and both of these assets need to be financed temporarily until collections on outstanding amounts are effected.

#### 2.4 WORKING CAPITAL POLICY

Working capital policy refers to the basic policy decisions of the firm regarding the optimal level of investment in, and the optimal financing of, current assets (Correia, Flynn, Uliana & Wormald, 1993:463). So the method of financing the permanent and seasonal working capital requirements of the firm will determine the working capital policy to be followed. Most firms attempt to 'match' the maturities of assets and liabilities to a greater or lesser degree (Brealey & Myers 1991:727), depending on their attitude to risk.

In general, three working capital policy approaches are recognised in the literature, namely the aggressive, conservative and moderate approaches to working capital financing.

The aggressive approach results in the firm funding its seasonal needs with short-term funds and its permanent needs with long-term funds. In essence, this approach is 'matching' the funding duration with its debt maturities. By funding seasonal assets with short-term funds, the cost of funding is minimised for the firm, as interest is paid on funds only during the time they are utilised. This positive effect on the firm's returns is accompanied by an increase in its risk exposure. The heavy reliance on short-term sources of funds to finance seasonal or temporary needs means the firm is running the risk of having to apply for costlier, less accessible long-term funds if seasonal

requirements exceed forecast levels.

The conservative approach to firm funding is to meet all projected financing requirements with long-term funds, relying only on short-term sources in the event of an emergency or unexpected outflow of funds. This approach means that long-term funding would be costlier to the firm, having an adverse effect on returns. On the other hand, there would be virtually no threat of running out of funds, so the liquidity risk would be at a minimum.

The moderate approach is a compromise between the aggressive and conservative approaches, with a mix of short-term and long-term funding somewhere between the two. The extent of the trade-off between return and risk is largely dependent on the firm's attitude towards risk.

To summarise, the aggressive strategy does not require the firm to pay interest on unutilised funds, as does the conservative approach - hence it is the more profitable. However, it is also the riskiest approach, and for most firms, the acceptable financing strategy is a trade-off somewhere between these two extremes (Gitman 1994:648-652).

## 2.5 THE NEED FOR WORKING CAPITAL

The firm's need for working capital is dependent on the working capital requirements of the firm and the level of the various components of working capital that have to be maintained. Both aspects affecting the firm's need for working capital are, in turn, a function of numerous factors, as discussed in the sections below.

### 2.5.1 Working capital requirements

The firm's working capital requirements may be viewed as the capital required to finance its short-term or current assets, in order to conduct efficient day-to-day business. These requirements, according to Hampton and Wagner (1989:8) are a function of sales, cyclical factors, technological developments and the firm's philosophy.

There is a close relationship between growth in sales and the need to finance current

assets. With an increase in sales, there might be a direct increase in the investment in accounts receivable and inventory holdings for the firm. These increases in current assets resulting from the growth in sales need to be financed, where the leadtime for raising the finance is considerably shorter than in the case of fixed asset financing.

Cyclical fluctuations in product demand affect the level of seasonal working capital requirements. Similarly, fluctuations in the overall economic climate will also affect working capital requirements: in an upswing, for example, with an increase in sales, one could expect working capital requirements to also increase.

Technological changes and advancements, for instance, production process technology, could impact sharply on the need for working capital. Automation of an assembly line, for example, which leads to faster processing of raw materials, could mean a greater demand for raw materials inventory.

If the philosophy of the firm is to exercise caution, larger levels of cash might be required to be held compared to a firm prepared to operate with less liquidity. Or if the firm's philosophy is to pursue an aggressive debt collection policy, it would have less working capital tied up in accounts receivable than a firm following a more lax collection policy.

### 2.5.2 The level of working capital

The absolute level of working capital to be held in the form of cash, accounts receivable and inventories is a function of firm-specific factors. These factors are company size, nature of the firm, availability of credit, and the firm's attitude towards profits and risk (Hampton & Wagner 1989:9).

The company size factor implies that the working capital levels of large firms differ from those of small firms. This is so for a number of reasons: the percentage of working capital to total assets is normally greater in smaller firms, hence efficient working capital management is more important to them<sup>1</sup>. Furthermore, since small firms rarely have

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1 See Fieldsend, Longford and McLeay (1987:497-517); Hampton and Wagner (1989:9); and Osteryoung, Constand and Nast (1992:35).

access to the traditional financial market funding available to large public firms, they rely more on short-term sources of capital such as accounts payable and bank overdrafts for their funding requirements (Walker 1989:285).

The nature of the business and type of industry in which the firm operates, will affect the level of working capital requirement <sup>2</sup>. A service firm, one might argue, will not need to hold inventories, whilst a cash concern will not have accounts receivable. This point is also highlighted in table 1.1, where the ratios of current assets to total assets are the lowest (seven percent) for two firms (Kersaf and Sunbop) within the same beverages and hotels industrial sector. See table 5.1 for an indication of the sectors covered in the empirical research.

The availability of credit factor may be demonstrated as follows: if a firm does not have a securable line of credit to fall back on at short notice, it could be forced to maintain larger amounts of liquid assets. Again, small firms lacking the resources of their larger counterparts, could fall into this category.

If the attitude or philosophy of the firm is to aggressively pursue profits, it is more likely to accept a greater risk of liquidity in order to run on the least amount of net working capital, thus saving costs and enhancing profits. Risk-averse firms, in contrast, would hold higher levels of net working capital in order to minimise the risk exposure of the firm. The smaller the amount of risk a financial manager is willing to assume, the greater the amount of working capital he or she will keep.

## 2.6 SUMMARY

The purpose of this chapter was to provide a theoretical overview of the working capital management concept, which commenced with a brief examination of the historical evolution of the concept.

The working capital management concept had its origins in short-term accounting practices such as budgeting and financial forecasting. Heuristic criteria in the form of

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2 See Block and Hirt (1981:161); and Hampton and Wagner (1989:9).

financial ratio analysis gained acceptance in the early twentieth century, with the emergence of literature on liquidity and cash flow analysis in the 1950s. Advancements in operations research led to the application of mathematical programming of aspects of working capital management, for example, optimum holdings of cash, accounts receivable and inventories. The advent of high interest rates and deregulated money markets in the 1970s resulted in increased emphasis on the importance of working capital management, and paved the way for its recognition as a fully-fledged discipline in finance.

A number of definitions associated with working capital management were then explored, in order to provide clarity on the terminology to be adopted in the study. These definitions included working capital management, net working capital, the working capital cycle, and permanent and seasonal working capital.

The working capital policy of the firm is determined by the method adopted to finance permanent and seasonal working capital needs. Three approaches to working capital policy recognised in the literature are the aggressive, conservative and moderate approaches.

The firm's need for working capital is reliant on its working capital requirements and on the actual level of working capital held. The working capital requirements of the firm are a function of turnover, cyclical factors, technological developments and the firm's philosophy. The level of working capital held is, in turn, a function of company size, nature of the firm, availability of credit and the firm's attitude towards risk.

The management of working capital should be guided by the overall objectives and strategies of the firm. The strategies applied in managing the components of working capital, namely cash, accounts receivable and inventory, and the method of financing of these components, all need to be part of the firm's long-term goal of shareholder wealth maximisation. In the following chapter, the individual components of working capital and appropriate techniques for their efficient management will be discussed.

## CHAPTER 3

### THE COMPONENTS OF WORKING CAPITAL

#### 3.1 INTRODUCTION

In the previous chapter, a literature overview of working capital management was provided. The focus of this chapter is on the second goal of the study, namely to examine the components of working capital as described by the literature.

The working capital components under scrutiny are cash, accounts receivable, inventories and short-term financing options. The goals of the different components, their nature and related aspects and recognised techniques for their efficient management are investigated. Suboptimum versus optimum working capital management models are then debated, and finally the concept of integrated working capital management is advocated.

#### 3.2 CASH MANAGEMENT

Cash is appropriately the first of the working capital components to be explored. Not only is cash the most liquid of all the components - it is central to the working capital cycle of the firm<sup>1</sup>. In this section, several aspects of cash management will be examined. These include the goal of cash management, its role in the firm, methods of cash management, the investment of excess funds and cash flow forecasting.

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1 The working capital cycle was discussed in section 2.3.3.

### 3.2.1 The goal of cash management

Traditionally, the goal of cash management was to supply sufficient funds to service the daily activities of the firm, with heavily accounting-oriented approaches developing around this point of view (Penning 1985:31). These approaches neglected the investment and income-generating possibilities of excess cash. More recently, writers such as Leitch, Barrack and McKinley (1980:58) and Perry (1982:20), specified the goal of cash management as the maintenance of the liquidity of the firm so that current obligations could be met at the lowest possible cost. Johnson and Aggerwal (1988:81) regard the minimisation of the time taken to get cash into the business and the maximisation of time out as the optimum goal. Yet another opinion is expressed by Seidner (1991:39), who regards the minimisation of the time taken to get cash into the business and the maximisation of time out as the optimum goal. He goes on to say that a competitive rate of return on excess cash should be achieved with minimum risk, at the same time ensuring that the cash is available when needed.

All these viewpoints concur that the cash management problem has at least two facets. Firstly, there should be sufficient cash inflows into the firm, which implies adequate sales, a healthy credit policy, and, among other things, effective collection practices, together with efficient cost control. Secondly, there is the question of efficient application of the cash generated in the activities of the firm. This cash is used to meet current obligations, to finance fixed and current assets, and where appropriate, excess cash needs to be invested to earn a yield (Penning 1985:32).

In summation, the goal of cash management is perhaps most comprehensively defined by Gup (1987:401), who views it as the maintenance of the minimum cash balance that will provide the firm with sufficient liquidity to meet its financial obligations, while enhancing its profitability, without exposing the firm to undue risk.

### 3.2.2 The role of cash in the firm

The role of cash in the firm has widespread recognition in the literature in terms of Keynes's three motives for the holding of cash. These motives are the transactions

motive, the precautionary motive and the speculative motive (Keynes 1936:168).

The transactions motive, the most important of the three, is defined as the motive for holding cash in order to carry out day-to-day business transactions, and firms that have predictable inflows and outflows of funds can hold relatively less cash than firms with irregular cash flows, without interrupting the firm's operations. The precautionary motive for holding cash is to meet unexpected demands and needs, and is related to the nature and business activity of the firm. The speculative motive, according to Keynes, has as its objective 'securing a profit from knowing better than the market what the future will bring forth' (Keynes 1936:170). This motive is the least common of the three, but when firms do have excess cash, they invest it in marketable securities to earn returns until they need the funds (Gitman 1994:690).

### 3.2.3 Methods of cash management

Methods of cash management can be evaluated according to two approaches, in pursuit of the goal of cash management as described in the preceding section. The two approaches are to view cash either as a financial asset or as a physical asset (Gup 1987:401). The objective of the first approach is the minimisation of the cost of the cash conversion cycle. The second approach uses inventory control models to calculate appropriate cash levels. These two approaches will now be addressed in more detail.

#### 3.2.3.1 *Cash as a financial asset*

In viewing cash as a financial asset, the cash conversion cycle, cash turnover and minimum operating cash concepts are strategies that may be employed in the pursuit of optimum cash management.

The cash conversion cycle is succinctly described by Gitman (1994:697) as the amount of time that elapses from when a firm outlays cash for the purchase of raw materials until cash is collected from the sale of the finished product using the raw material. Within this cycle, there are (1) two assets, namely inventory and accounts receivable, which are generated at different times, and must be financed; and (2) one set of liabilities, accounts

payable, that provides the financing (Scherr 1989:356). Methods of reducing the length of the cash conversion cycle are (1) to stretch accounts payable as long as possible, without damaging the credit rating of the firm, and still taking advantage of discounts on purchases; (2) collect accounts receivable as soon as possible, without alienating new or existing customers; and (3) increase inventory turnover, either by increasing sales or shortening the production cycle.

Cash turnover is simply the number of times per year that the firm's cash is actually turned into a saleable product and then back into cash. The cash conversion cycle should be kept as short as possible, which means that the cash turnover of the firm is high with a resultant reduction the average cash balance and therefore the cost of holding those funds (Gup 1987:403).

The minimum operating cash concept has to do with establishing an optimal minimum cash level, in order to operate the firm in a fashion that requires the least funds. A simple method of estimating this minimum operating cash level is to divide the firm's total annual outlays by its cash turnover (Gitman 1988:514). In order to estimate the cost of these funds, the minimum operating cash of the firm can be multiplied by its opportunity cost.

### **3.2.3.2      *Cash as a physical asset***

In viewing cash as a physical asset, inventory control models are applied to the management of cash and marketable securities, in order to determine the optimum level of investment in cash and marketable securities (Gup 1987:401). Two such inventory control models are the Baumol model and the Miller-Orr model.

The Baumol model determines the optimal average amount that needs to be transferred from the firm's marketable securities portfolio into its cash account in order to meet the firm's demands for cash over time (Baumol 1952:545-556). The two major contributions of the Baumol model are that firstly, the minimisation of the total cost of holding cash is addressed at the same time as the question of maintaining sufficient liquidity; and secondly, the two costs of cash management are identified. The total cost of holding cash is equal to the ordering cost of converting marketable securities into cash, plus the

opportunity cost suffered by holding idle cash. The ordering cost is derived by multiplying the transactions cost for a single conversion of marketable securities into cash by the number of transactions that occur during a given period. The opportunity cost is derived by multiplying the interest rate on short-term marketable securities by the average cash balance held.

Two limitations of the Baumol model are that it assumes firstly, the existence of certainty regarding expected cash balances, and secondly, the assumption of steady cash disbursements over time. These limitations are addressed in the Miller-Orr model (Miller & Orr 1966:413-435), which employs a finite, stochastic process, defined as a series of events that can be analysed using probabilities. Unlike the Baumol model, the Miller-Orr model assumes uncertainty and random fluctuations in the cash balances within an upper and lower boundary. If the cash balance reaches the upper boundary (H), the firm will invest the excess cash, in this way returning the cash balance to the optimal level (Z). If the cash balance reaches the lower limit (L), the firm will sell sufficient marketable securities to increase the cash balance to the optimal level.

The decision problem of the Miller-Orr model is the determination of the values of Z and H that minimise the cost of transferring funds and the opportunity cost of holding idle cash (Gup 1987:414). The total cash costs are a function of the cost of converting cash into marketable securities or vice versa, times the yearly number of transfers, plus the lost return on idle cash, times the average or optimal cash balance. The model seeks to find the optimal level of cash that trades off the transfer costs against lost opportunity costs within a variable cash flow framework. The optimal cash balance is computed from an optimisation formula in which the standard deviation of cash flows is used as the cash flow variability measure. Point Z may be determined by the following equation (Gup 1987:415):

$$Z = \sqrt[3]{\frac{3 B \sigma^2}{4 i}} + L$$

where

|                            |   |   |
|----------------------------|---|---|
| <b>B</b>                   | = | fixed cost per order of converting cash into marketable securities, or vice versa |
| <b>i</b>                   | = | daily interest rate on short-term marketable securities                           |
| <b><math>\sigma</math></b> | = | standard deviation of daily cash balances   |
| <b>L</b>                   | = | lower limit   |

If a firm holds the cash balance obtained by the formula, and replenishes or invests when the boundaries are reached, the lowest possible total costs for cash management should be incurred. Hence the Miller-Orr model identifies the need to evaluate probabilistic cash flows systematically, along with the incorporation of the costs of the Baumol model. In recognising the twin costs of transactions and lost opportunities, and the probabilistic environment of cash receipts and payments, sufficient liquidity needs to be maintained to cover daily fluctuating operating needs.

Excess cash should be invested to achieve a return. The optimal cash balance is thus the level of cash and marketable securities that meets liquidity needs and simultaneously minimises lost short-term opportunity costs (Hampton & Wagner 1989:156). Two important concepts prevalent in the above inventory models of cash management are the investment of excess funds in a risk-return framework, and the estimation or forecasting of cash flows. These two concepts will now be examined.

### 3.2.3.3 *The investment of excess funds*

Once an efficient system of minimising idle cash balances has been established, excess cash needs to be invested in order to earn a yield on the funds. The trade-off here is one of maintaining sufficient liquidity whilst achieving a reasonable return at a level of risk that is acceptable to the firm. Here the firm needs to define the degree of risk it is willing to take in investing excess cash (Hampton & Wagner 1989:163). The maturity of the investments is the major concern, and should be determined by the date on which the cash will be needed. The longer the maturity, the greater the exposure will be to a loss

of principal, should the instrument need to be sold when interest rates are higher than they were when the instrument was purchased.

An option might be to invest in instruments with different maturities. For example, a firm may choose to invest a small amount of the total excess funds in a short-term maturity in order to meet an immediate need for funds. An analysis of rate of return, or yield curves, of various available instruments could be undertaken. One would expect that the longer the maturity of the investment, the higher the rate of return would be.

In this regard, Seidner (1991:40) considers interest-bearing securities as the mainstay of the corporate excess cash portfolio. Ordinary shares are too volatile as short-term instruments, but not so with preference shares, variations of which provide some immunity to market price fluctuations, even though they do not have a specific maturity. Money market mutual funds could be attractive to a small pool of investment funds as they are typically invested in maturities of less than 60 days. This means that their asset values remain constant, whilst earning an acceptable rate of return. Other investment instruments are government issues such as Reserve Bank treasury bills, and nongovernment issues, including municipal securities, negotiable certificates of deposit, commercial paper and bankers' acceptances.

In a time of increasing flexibility and complexity of financial instruments, coupled with deteriorating profit margins, firms cannot afford to forego opportunities for enhancing yields on short-term funds. Nor can they afford not to minimise risk through well-informed, effective excess cash investment (Seidner 1991:41).

#### **3.2.3.4**      *Cash flow forecasting*

Cash flow forecasting is the process of determining the net cash flow of the firm over a specified period. The initiation of a cash flow forecast constitutes three sets of assumptions regarding, firstly, sales, profit margins and credit periods extended; secondly, production, inventory holding and time taken to pay suppliers; and thirdly, the external environment relating to interest rates, exchange rates and inflation movement over the forecast period.

When forecasting sales, subjective and statistical methods may be combined for improved accuracy. Subjective methods of sales forecasting include firstly, the use of sales force opinions, contributing by means of their subjective judgement of future product demand; secondly, the incorporation of forward orders into the forecast, coupled with the estimate for future orders; and thirdly, the employment of market research in the determination of the firm's expected market share of total estimated product demand.

Statistical techniques such as time series and regression may be employed for the forecasting of sales (Unisa 1994:62-64). By using historical data to estimate a future sales trend, time series models project the relationship that applied between past sales and time by means of trend fitting, moving averages and exponential smoothing. Regression models make use of past data to derive a model by testing possible relationships between variables. Sales, the dependent variable, would be tested to find the relationship between itself and the independent variables, such as advertising expenditure, distribution channels and competitors' prices. Regression models are useful to ascertain major turning points and to forecast the possible impact of a change in any of the variables that affect demand.

Subjective forecasting could contain the element of bias, but has the advantage of being dynamic in nature. Statistical forecasting, on the other hand, relies heavily on historical data, which could lead to distortion in changing circumstances (Correia et al 1993:482).

A production forecast can be made from the sales projections. Anticipated stock levels and purchases of raw materials can be forecast. By then applying the assumptions to lead times and payment terms, cash outflows on purchases can be projected. Other expenses such as wages, electricity, insurance and overheads such as rates and salaries, can be estimated and included in the forecast of disbursements (Unisa 1994:64).

To be effective, cash flow forecasts need to be monitored and compared to actual flows. In this way, opportunity profits or losses which have occurred because of poor predictions or major changes in underlying assumptions may be exposed.

### **3.2.4 Cash management in conclusion**

Although the rand investment in cash (see table 2.1) is typically less than the investment in accounts receivable and inventories, the continuing flow from cash to supplier to accounts receivable and back into cash makes it the lifeblood of the firm. Stated differently, because a firm can be managed with less cash, this does not mean that cash is less important; rather the available cash needs to be managed optimally to ensure the continued liquidity of the firm.

## **3.3 ACCOUNTS RECEIVABLE MANAGEMENT**

The use of credit is widespread among South African firms, as illustrated in table 2.1, where accounts receivable make up 46 percent (on average) of current assets held by listed companies. Accounts receivable play an essential role in the working capital cycle, where the generation of sales results in immediate cash or accounts receivable. When the latter are collected, they too provide cash. In this section, the management of accounts receivable will be examined, the goal and methods of accounts receivable management forming the core of the discussion.

### **3.3.1 Goal of accounts receivable management**

The goal of accounts receivable management, as with other functional areas in the firm, must be pursued within the realms of the overall goals and objectives of the firm. Block and Hirt (1981:77) point out that accounts receivable should be managed in such a way that the maximum return on the asset should be obtained, whilst promoting the achievement of the overall goals of the firm.

### **3.3.2 Methods of accounts receivable management**

An exhaustive study by Srinivasan and Kim (1988:198) of normative research in accounts receivable management revealed that the management focus has been on three major decision-making areas, namely credit granting, the analysis of credit policy changes and the control and management of investment in accounts receivable.

### 3.3.2.1 *Credit granting*

Credit granting is a function of the accounts receivable strategy of the firm as described in its credit policy. The credit policy sets out guidelines for determining whether or not to extend credit to a customer, and how much credit to extend (Gitman 1994:724). Credit standards and credit terms need to be established in order to make credit policy decisions.

Credit standards are the criteria used in the credit granting decision, determining the maximum risk a firm is willing to assume in extending credit (Gup 1987:434). By lowering credit standards, credit sales and accounts receivable can be increased, but at the same time, collection costs and bad debt exposure are increased. A number of authors (eg Gitman 1994:724; and Gup 1987:435-436) propose the 'five Cs' of credit evaluation in developing sound credit standards. These 'five Cs' are delineated below:

**character:** the character of the customer regarding past payment behaviour, honesty, integrity and consistency

**capacity:** the ability of the customer to meet financial obligations, revealed in current and pro forma financial statements

**capital:** the financial condition of the customer, or the net amount of assets less liabilities that could be liquidated for the payment of debt

**collateral:** assets of the customer pledged as security against the credit granted

**conditions:** economic and other factors beyond the control of the customer that might inhibit the customer from being able to meet obligations.

Credit terms specify the repayment terms, referred to as the credit period, the size of the cash discount awarded for early payment and the period of time in which the cash discount must be taken. Credit terms vary widely from industry to industry<sup>2</sup>, each having a particular norm. By varying the credit terms, a firm could influence sales, but it is likely to face a competitive reaction as a result.

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2 In this regard see Bishop, Crapp, Faff and Twite (1993:608); and Gup (1987:441).

### **3.3.2.2      *The analysis of credit policy changes***

In analysing the effect of changes in credit standards and terms, Gitman (1994:730-731) defines three key variables. The first variable is the sales volume: firms can relax their credit standards and terms to increase sales, or gain market share; increases in sales, in turn, may have a positive effect on the firm's profits. The second variable is the investment in accounts receivable: the higher the investment in accounts receivable, the greater the cost of carrying the asset will be for the firm. In relaxing credit standards and terms, accounts receivable will increase. This could have an adverse effect on profits. The third variable is the bad debt expenses: as standards and terms are relaxed, the bad debt risk exposure increases. This has a negative impact on profits. Again, a tightening of policy could have a positive impact on profits.

### **3.3.2.3      *The control and management of investment in accounts receivable***

The control and management of investment in accounts receivable is achieved by means of collection policies and credit control. An aggressive debt collection policy, for instance, should reduce both the investment in accounts receivable and the firm's bad debt exposure, thereby enhancing profits. On the other hand, an overly aggressive policy could chase away potential customers.

The value of funds tied up in accounts receivable is a function of a firm's collection policies. Dun and Bradstreet (Gup 1987:445-447) recommend that the collection period should be no longer than one-third more than the firm's net selling term. To illustrate: if a firm's net selling terms are 30 days, the collection period should not exceed 30 days plus one-third more, namely 40 days. In order to gauge the effectiveness of its collection policies, a firm needs to compare its average collection period and ageing schedule with industry averages, recent trends and its own credit terms. Furthermore, the firm needs to balance profits, sales and composition of assets in the establishment of a collection policy.

The credit control task is a function of a firm's external and internal controls. External controls on the extension of credit set limits on the value of credit to be granted to

particular customers. Generally, these limits are established according to the customer's needs and ability to pay. Internal controls monitor the aggregate amount of credit that the firm extends. Ratios such as average collection period (an indication of how long a firm has to wait before receiving cash for credit sales) and the ratio of bad debts to credit sales (a measure of the 'quality' of the accounts receivable) are both internal control measures in the accounts receivable management strategy of the firm.

### 3.3.3 Link between accounts receivable and inventories

With due consideration for the factors involved in the management of accounts receivable, the link between accounts receivable and inventories should be taken into account in the evaluation of alternative credit strategies for the firm. If a change in credit policy results in an increase in sales, for most firms this would mean an increase in the inventory level. There is an opportunity cost common to the tie-up in both accounts receivable and inventories (Schiff 1980:382). This means that in order to maximise returns, credit and inventory policies should be jointly developed, with recognition for the trade-off of costs between the two areas of working capital management.

## 3.4 INVENTORY MANAGEMENT

Inventory is the least liquid of the current assets of the firm, and its management is complicated by its variable nature within the firm. Furthermore, all the functional areas of a typical firm are either directly or indirectly affected by decisions on inventory. In this section, the conceptual framework for the management of inventories will be discussed. In order to make decisions on the trade-offs involved regarding kinds and levels of inventories to hold, the goal, nature and investment in inventories will be briefly addressed. The economic order quantity model for the formulation of ordering strategies will also receive attention.

### 3.4.1 The goal of inventory management

The goal of inventory management is the formulation of strategies for the ordering and holding of inventories that will be the most advantageous for the firm (Scherr 1989:281).

The challenge is to find the inventory level that minimises the three costs involved in inventory management, namely the cost of being out of stock and the costs of ordering and holding inventories.

#### 3.4.2 Nature of inventories

Unlike other current assets, inventories are physical rather than purely financial in nature. But as with all other assets, inventories represent a costly investment to the firm, and as such, there must be a benefit to carrying inventories. The reasons for holding inventories vary with the type of inventory carried, namely raw materials, work-in-progress or finished goods.

Raw materials, in a manufacturing environment, are the items that have not yet been committed to the production process. Firms carry raw materials inventory to facilitate the scheduling of production, to avoid price changes in the future and to hedge against supply shortages.

Work-in-progress is represented by raw materials that have entered the production stream, and are now partially-finished goods at some intermediate stage of completion. The reason why firms might keep excess work-in-progress inventory is to allow for flexibility in the production process and to avoid process breakdowns.

Finished goods inventory consists of items that have passed through the manufacturing phase but have not yet been sold. Finished goods inventory is held so that goods are readily available for customers, especially in the case of unplanned demand, and for the stabilisation of production runs that use the same technology (Scherr 1989:281-283).

#### 3.4.3 Investment in inventories

The extent to which firms invest in inventories is a function of both their position in the product life cycle and their industry type. Firms in the early phases of the product life cycle hold more inventory relative to total assets than those in the later phases (Gup 1987:461).

The level of sales generally conforms with the firm's level of business activity. So one strategy for investment in inventories is to regulate the level of inventories according to the level of sales, which would involve keeping the inventory to sales ratio constant. This may not always be feasible during the peaks and troughs of a business cycle.

An alternative investment strategy would be to keep the inventory investment at the lowest level that will enhance the firm's long-term profitability. One way of doing this is to increase the inventory turnover ratio. Another way is to hold less inventory for the same level of sales. However, in this way, the chance of enhancing returns attracts the risk of being out of stock, which could mean a loss in revenue. Both these strategies have as their focus the reduction of the total cost of holding inventories. The following section focuses on the components of total cost and some techniques for minimising them.

#### 3.4.4 Economic order quantity

The economic order quantity model (EOQ) is one of the most commonly cited techniques for determining the optimal order quantity for an item of inventory (Gitman 1994:747). The objective of the model is to determine a level of stockholding that minimises the firm's total cost of inventory management. The model determines the order quantity that minimises total inventory costs by dealing with the trade-off between carrying costs and ordering costs. The greater the quantity ordered, the lower the ordering costs but the higher the carrying costs will be (Beaumont 1991:36).

Bearing in mind that the domain of a mathematical model is limited to situations covered by the model's assumptions (Scherr 1989:289), the constraints of the model need to be considered. These constraints are the assumptions that sales can be perfectly forecast and are evenly distributed throughout the year, and orders are received without any unexpected delays (Correia et al 1993:506).

The EOQ is represented by the following formula:

$$EOQ = \sqrt{\frac{2SO}{C}}$$

where S = usage in units per period  
 O = order cost per order  
 C = carrying cost per order.

Since the EOQ model assumes a certain and constant demand, a firm would need to hold a safety stock of inventory to cope with uncertainty in demand or usage. In determining the level of safety stock to hold, there is a trade-off between the costs of running out of inventories and the carrying costs of increasing the level of inventory to a desired level of protection against an 'out-of-stock' situation (Bishop, Crapp, Faff & Twite 1993:617). The EOQ model can be adjusted for the expected out-of-stock costs by adding these costs to the order costs. The cost of holding safety stocks should be added to the carrying costs. Both thus increase the total cost of holding inventories.

#### 3.4.5 Inventory policy

The EOQ model focuses on an optimal strategy of inventory replenishment in response to the demand for individual items of inventory. Where a firm holds many diverse items of inventory, it may be necessary to use an inventory classification system, known as the ABC method. Here inventories are divided into three categories - A, B, and C - based on the amount of investment in each category.

The A category includes those items that require the greatest rand investment. In a typical distribution of inventory items, the A category consists of 20 percent of inventory items and accounts for 80 percent of the firm's rand investment (Gitman 1994:746). The B category is made up of those items that represent the next largest investment, and the C category normally consists of a large number of items that represent a relatively small total rand value. The extent of control over the three categories is then varied according to the rand investment. This would mean that a high degree of control would be exercised over category A items, less over category B, and category C might not justify rigid controls at all.

A cost-balancing approach needs to be applied to the establishment of inventory controls when deciding on inventory policy for the firm. In other words, inventory controls should be applied to additional items as long as expected benefits to the firm exceed the added cost of developing and maintaining the system.

#### 3.4.6 Inventory management in conclusion

The inventory management function rests on fundamental principles. The inventory policy needs to be compatible with the firm's operations by ensuring the availability of goods to support efficient production and to meet the needs of customers in a competitive market. In short, inventory policy affects all phases of the business operation, and as such, needs to be an integral part of it.

### 3.5 SHORT-TERM FINANCING

Traditionally, finance with a maturity of up to one year qualifies as short-term financing, although most short-term financing options have a maturity of substantially less than a year (Hill & Sartoris 1988:313). In this section, the focus will be on the goal and most common sources of short-term financing available.

#### 3.5.1 The goal of short-term financing

The goal of short-term financing is twofold. Firstly, it should meet the firm's requirements for short-term financing, and secondly, it should be in keeping with the firm's target level of liquidity. This goal needs to be achieved at the minimum cost to the firm (Scherr 1989:382).

#### 3.5.2 Sources of short-term financing

Sources of short-term financing vary in terms of maturity, cost and availability. Among the most popular short-term financing options are accounts payable, accruals, commercial paper, bankers' acceptances, unsecured lines of credit and secured short-term borrowing.

Accounts payable, representing trade credit provided from one firm to another for the credit purchase of goods, are the most conventional spontaneous form of short-term financing. Accounts payable represent an interest-free source of funds because no charges are levied, provided the account is not overdue. Accruals also represent an interest-free spontaneous form of short-term financing, and occur when the firm has received services for which it has not yet paid. Examples of these are wages payable and taxes payable. In both cases, the firm has use of the money until payment is made.

Commercial paper takes the form of unsecured promissory notes issued by large nonfinancial firms. Other firms purchase commercial paper with the intention of investing excess cash to earn a yield higher than the one available on government treasury bills. To the issuing firm, it is a means of obtaining short-term credit, usually for a period of 30 days, without having to provide security, at an interest rate generally below the direct borrowing rate offered by banks. Bankers' acceptances differ from commercial paper in that they are guaranteed by both the bank and the issuing firm. This guarantee makes them a safe investment, and hence the rate of interest they earn is lower than that of commercial paper. Letters of credit used in international trade transactions are an example of this form of short-term finance, which has a typical maturity period of 90 days.

An unsecured line of credit is a short-term loan, unsecured by collateral, which financial intermediaries offer to firms with a sufficiently strong financial position to justify the loan. The cost of these borrowed funds is normally based on the current prime overdraft rate. Although it is a simple and flexible means of obtaining short-term finance, banks require that lenders use an unsecured credit line as a temporary measure, and not to meet permanent short-term financing requirements (Scherr 1989:389).

Secured short-term borrowing refers to funds advanced by lenders who require the pledge of an asset as security. Because of this security, credit can be granted at a lower interest rate than if the funds borrowed were unsecured. In the case of liquidation of the borrower, the proceeds from the secured assets revert to the lender. Because current assets are the most liquid of all assets, lenders of secured short-term funds frequently require the pledging of marketable securities, accounts receivable or inventories as security. Marketable securities may be pledged by means of a reverse repurchase

agreement; accounts receivable by providing a portion of the accounts receivable portfolio as collateral, or by factoring or selling accounts receivable to the financial intermediary; and inventory by means of a general inventory lien or a trust receipt, giving the lender a security interest in the inventory (Scherr 1989:291-404).

### 3.5.3 Summary of short-term financing

There are numerous sources of short-term funds available to finance working capital needs. Each source provides a trade-off of the flexibility of the source against the cost of financing. Unsecured financing has greater flexibility, but the costs are higher than for secured financing. The appropriate short-term financing mix can be obtained by ascertaining the net availability and costliness of each source. The optimum financing plan would be the sequential harnessing of least-costly sources, proceeding to more costly funding as required.

## 3.6 INTEGRATED WORKING CAPITAL MANAGEMENT

The literature on working capital management and its components has, to a large extent, concentrated on individual current assets and liabilities, resulting in less than optimum decisions being made. For instance, a suboptimum decision made in one division of the firm may not coordinate with a suboptimum decision made in another division, and the outcome might not be ideal for the firm as a whole.

Many finance writers have highlighted the need for an optimum decision approach (Van Horne 1992:374). Optimum theories on working capital management study the effects of all current assets, taken together, on the asset and capital structure of the firm, and attempt to treat the discipline as an integrated whole. Some of the approaches addressing the problem of optimisation of working capital decisions are now briefly discussed.

Proper integration of the different parts of the working capital process requires that cross-sectional interrelationships between the functional activities be considered simultaneously with the intertemporal dynamics of the connections between the working capital elements that might be out of phase with each other, or have different short-term and long-term

ramifications (Crum, Klingman & Tavis 1983:343). Crum et al (1983:343) propose a large-scale integrated modelling approach in the attempt to find an overall optimum integrated working capital strategy. By incorporating computer simulation into a financial planning optimisation model, they attempt to overcome the shortfalls of using either only simulation or optimisation techniques.

The interrelationship between the different short-term financial decisions is addressed by Hill and Sartoris (1988:43-45). The policies established for the management of short-term assets and liabilities result in a mixture of separate and interrelated decisions. Most of these short-term decisions will affect amount and timing of cash flows within the firm. They advocate the use of a cash flow time line approach to measure the effect of these decisions on a firm's cash flows. This integrated approach to the interrelationship between the different areas of the firm should reduce the possibility of a less than optimal decision being made.

Gitman (1988:557-558) and Schiff (1980:372-383) refer to the need for an interface between accounts receivable and inventory management in effecting cost trade-offs between the two, in order to enhance their planning and control. Schiff suggests combining the accounts receivable function and the inventory function into a new independent organisational unit. This would provide for the positive use of credit as an income-generating expense, as opposed to the typical negative cost-aversion approach of firms. He maintains that this approach should result in policies that generate the maximum return on investment in accounts receivable and inventory.

Srinivasan and Kim (1988:188-200) conceptualised a decision support system that provides a taxonomic framework for working capital decisions. The entire set of decisions relating to cash, accounts receivable, inventories and accounts payable can be grouped as infrastructural, operational and variance analysis decisions in the construction of an analytical framework for the augmentation of working capital policy.

The successful functioning of the firm is dependent on integrated cooperation between the different functional areas of the firm (Marx & Churr 1980:123). It follows that it is unrealistic to study the management and activities of a specific function in isolation

(Penning 1985:1). Therefore, the management of working capital can only be optimised by adopting an integrated approach to the management decisions of the different components of working capital.

### 3.7 SUMMARY

In this chapter, the working capital components of cash, accounts receivable, inventories and short-term financing were examined in terms of the literature. This was done by briefly discussing the goals, nature and recognised management techniques of each component.

The goal of cash management is to maintain the minimum cash balance that will provide the firm with sufficient liquidity to meet its financial obligations, and enhance returns, without exposing it to undue risk. In the pursuit of this goal, cash can be viewed as a financial or physical asset. In viewing cash as a financial asset, management would attempt to minimise the cost of the cash cycle. In viewing cash as a physical asset, management would apply inventory control models, for example, the Baumol or Miller-Orr models, to determine optimum holdings of cash and marketable securities. Two important concepts prevalent in the inventory control models are the investment of excess funds in a risk-return framework and the forecasting of cash flows.

The goal of accounts receivable management is the pursuit of the maximum return on the asset, whilst promoting the overall goals of the firm. The focus on accounts receivable management in the literature, has been on credit granting, which has to do with the setting of credit standards and terms; the analysis of credit policy changes; and the control and management of investment in accounts receivable, by means of collection policies and credit control. In evaluating alternative credit strategies, the cost trade-off between accounts receivable and inventories needs to be considered.

The goal of inventory management is to pursue the level of inventory holding that minimises inventory costs. Inventories consist of raw materials, work-in-progress and finished goods. The firm's investment in inventories is a function of its position in the product life cycle and its industry type. The EOQ model focuses on the determination of

the best inventory replenishment strategy for the firm. Inventory policy affects all phases of the business operation, and therefore needs to be an integral part thereof.

Short-term financing meets the immediate funding needs of the firm, and sources of short-term financing vary in terms of maturity, cost and availability. The most conventional sources are accounts payable, accruals, commercial paper, bankers' acceptances, unsecured lines of credit and secured short-term borrowing. By ascertaining the net availability and costliness of each source, the appropriate short-term financing mix for the firm can be established.

Much of the literature on the management of working capital concentrates on its individual components, rather than viewing the discipline as an integrated whole. Some finance writers have stressed the need for an integrated, optimum decision approach to the management of working capital, arguing that the successful functioning of the firm is dependent on the integrated cooperation between the different functional areas. It follows that it is unrealistic to study the management of the individual working capital components in isolation.

Miller (1988:41) points out that the objectives of working capital management are the preservation of capital and the maximisation of liquidity and return. The last two objectives are the focus of the following chapter, in which traditional and alternative measures of liquidity, and generally accepted measures of return will be examined.

## CHAPTER 4

### WORKING CAPITAL MEASURES DEFINED

#### 4.1 INTRODUCTION

In the previous chapter, the components of working capital were examined, culminating in the promotion of the concept of integrated working capital management. The purpose of this chapter is the attainment of the third goal of the study, namely to identify in the literature the working capital measures of traditional and alternative liquidity ratios, and to identify recognised measures of return. The logical departure point here is the risk-return trade-off.

#### 4.2 THE RISK-RETURN TRADE-OFF

In all financial decisions taken, there exists a trade-off between risk and return in that the greater the risk the firm is willing to take, the greater the required return will be. The concept of return implies that the firm's operations will increase the wealth of the owners, while the element of risk lies in the ability of the firm to meet its financial needs timeously, however unexpected. Most textbooks on working capital management address this risk-return trade-off. Hampton and Wagner (1989:10), for instance, propose that the risk-return trade-off in the management of working capital be analysed according to three components, namely liquidity, return and the cost of financing. The third component was briefly examined in section 3.5 under short-term financing. The first two components, liquidity and return, and their measurement, are now examined more closely.

### 4.3 THE LIQUIDITY COMPONENT

The liquidity component in the risk-return trade-off can be defined as the ability of the firm to satisfy its short-term financial obligations as they fall due (Gitman 1994:113; Scherr 1989:352). A further consideration regarding liquidity is the generation of some level of return for the owners, an issue which was addressed in section 3.2.3.3. In this section, traditional liquidity measures will be identified and viewpoints on their shortcomings considered. Thereafter attention will be given to alternative measures of liquidity, which attempt to overcome these shortcomings.

#### 4.3.1 Traditional measures of liquidity

The literature on financial management is consistent in the recognition of several financial ratios as traditional measures of liquidity. Financial ratios describe, in a simple mathematical form, a fixed relationship between two figures.

The Bureau of Financial Analysis (BFA 1989:1) stipulates two prerequisites for effective ratio analysis: firstly, there should be a meaningful relationship between the numerator and the denominator to facilitate significant data inferences; and secondly, there must be a standard against which the absolute value reflected by the ratio can be measured in relative terms, by comparing it with other similar values. In this regard Gitman (1994:107-109) and Hampton and Wagner (1989:260) consider ratios to be particularly useful for spatial and temporal analyses.

Spatial analysis<sup>1</sup> involves comparing firms within the same industry at one point in time. Ratios associated with successful versus unsuccessful firms are highlighted and industry averages computed so that deviations from the average can be noted and acted upon.

Temporal analysis<sup>2</sup> is applied to compare the financial performance of firms in an industry or across industries over time. Firms are evaluated according to past performance, and developing trends used to isolate possible future problem areas.

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1 Spatial analysis is also known as cross-sectional analysis.

2 Temporal analysis is also known as time-series analysis.

Combined analysis synergises spatial and temporal analysis, thereby allowing for the assessment of trends in ratio behaviour in relation to industry tendencies.

In their measurement of liquidity, financial ratios can be defined according to whether they measure working capital position, working capital activity or leverage (Emery 1984:26; Lovemore & Brümmer 1993:83). The ratios most frequently observed in the literature as measures of working capital position, working capital activity and leverage, are now focused on.

#### *4.3.1.1 Working capital position*

Working capital position ratios measure the degree to which the firm's currently maturing obligations are covered by currently maturing assets. The most widely recognised traditional measures of working capital position in the literature are the current ratio and the quick ratio.

The current ratio is regarded as a broad measure of liquidity and is expressed as current assets divided by current liabilities. A low current ratio is viewed as an indication that a firm might not be able to meet future obligations timeously, while a high ratio might indicate excessive holdings of low-yielding assets, which could adversely affect returns (Gup 1987:318; Hampton & Wagner 1989:264).

The quick ratio is considered to be a narrow measure of liquidity and is expressed as current assets minus inventory<sup>3</sup> divided by current liabilities. A quick ratio of at least 1,0 is often recommended in practice, but like the current ratio, an acceptable value is largely dependent on the industry (Gitman 1994:115).

#### *4.3.1.2 Working capital activity*

Working capital activity ratios attempt to measure the relative efficiency of the firm's resources by relating the level of investment in different current assets to the level of operations (Gallinger & Healey 1991:73). Typical activity measures are inventory

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3 Inventory is viewed as the least liquid current asset.

turnover, accounts receivable turnover, accounts payable turnover and sales to net working capital.

Inventory turnover is defined as the cost of sales over average inventory. The average inventory figure is obtained by taking the average of opening and closing inventory balances<sup>4</sup> for the period under review. This ratio provides insight into the number of times the asset was turned over during the year, and the higher the turnover rate, the more efficient the inventory management will be. The average age of inventory can be computed by dividing the inventory turnover into 360, or the number of days in a year (Gitman 1994:117).

Accounts receivable turnover measures the speed of converting accounts receivable into cash, and is calculated as credit sales divided by accounts receivable. A high turnover rate is indicative of aggressive debt collection procedures, signifying a strict credit policy (Hampton & Wagner 1989:267). Where credit sales figures are not available, total sales may be used, on the assumption that cash sales are relatively insignificant. A reasonably constant annual proportion of cash sales to credit sales will result in a cogent year-to-year comparison of changes in the ratio (Bernstein 1989:524). The inverse of this ratio times the number of days in a year reflects the average collection period or weighted average time (Scherr 1989:353) that accounts receivable are outstanding.

Accounts payable turnover reveals the effectiveness of the management of a firm's short-term financing, and is represented by credit purchases divided by accounts payable. The lower the turnover rate, the more effectual the employment of the firm's short-term financing will be. A shortcoming of this ratio is the lack of disclosure of annual credit purchases in published financial statements. To approximate credit purchases, Kamath (1989:25) uses closing inventory plus cost of goods sold minus opening inventory, conjecturing that all sales occur on credit.

Sales to net working capital<sup>5</sup> centres on the proficiency of the utilisation of working capital. The higher the ratio, the greater the proficiency will be.

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4 By this we mean the total of opening and closing inventory divided by two.

5 In other words, sales divided by net working capital.

#### **4.3.1.3      *Leverage measures***

Leverage measures provide evidence of cash obligations attributable to the firm's long-term financing, demonstrating the existence of debt capacity that could be used to provide additional liquidity (Emery 1984:26). Frequently used leverage measures include long-term loan capital divided by net working capital, accounts receivable divided by accounts payable and total current liabilities divided by gross funds flow.

Long-term loan capital divided by net working capital provides evidence of the magnitude of the long-term loan capital financing of working capital. Long-term loan capital is the total of all loan funds procured on a long-term basis and as such not repayable within the ensuing financial year (BFA 1989:11). A lower ratio could be interpreted as healthy, since greater use is being made of cheaper short-term funding.

Accounts receivable divided by accounts payable reflects the degree to which credit extended by the firm is financed by the credit supplied by creditors. The lower the ratio, the more inordinate is the funding of the firm's credit by its suppliers.

Total current liabilities divided by gross funds flow, expressed in years, reflects the ability of the firm to repay the various short-term funds received from its gross funds flow. The total current liabilities and their most important components are divided by gross funds flow for the year, defined as the income after taxation plus the net nonfunds flow items of the firm (BFA 1989:39-40). The lower the measure, the more liquid the firm is.

#### **4.3.2      *Shortcomings of traditional measures of liquidity***

The literature advances a plethora of viewpoints on the shortcomings of traditional ratios as measures of liquidity. Some of these viewpoints are now considered for discussion.

Emery (1984:26) perceives as a deficiency of working capital position ratios their inclusion of assets not readily convertible into cash, whilst excluding the liquidity provided by potential sources of financing. Also, existing current liabilities represent only a portion of the firm's future cash obligations. In addition, the firm's cash flow is not related to its

supply of liquid reserves in the application of traditional ratio measures, and there is no known direct relationship between the values of the ratios and the likelihood of the firm meeting its cash requirements.

A myriad of authors<sup>6</sup> all agree on the static nature of traditional ratio analysis and point out that they cannot be relied upon to accurately estimate the pattern and size of future cash flows. Also, their imbedded margin of safety notion relies on a liquidation concept rather than a going-concern concept. Operating cash flow coverage, instead of asset liquidation value, should be the crucial element in liquidity analysis.

With further reference to the criticisms of the reliance of ratio analysis on the liquidation concept, Gallinger and Healey (1991:71-73) observe that a positive net working capital, considered to be an indication that the firm is solvent, is not necessarily true because a high positive net working capital<sup>7</sup> could arise from inordinately high investments in accounts receivable and inventories. Likewise nonmonetary assets such as inventories and prepaid expenses are included as if they were monetary items. If a forced liquidation were to occur, the realisable value of these assets would be relatively low.

The traditional ratios discussed in section 4.3.1 support the pervasive argument on their static nature and inadequacy in estimating future cash flows. Notwithstanding, the total current liabilities divided by gross funds flow<sup>8</sup> does consider the gross funds flow for the firm, albeit as historical data, rather than as a future estimation of the flow of funds.

#### 4.3.3 Alternative measures of liquidity

A number of alternative measures of liquidity have been developed over the years, in an attempt to overcome the shortcomings of traditional ratio analysis as a measure of liquidity. The most well documented of these alternative measures are the cash conversion cycle, the weighted cash conversion cycle, the comprehensive liquidity index,

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6 See for example Beyer (1988:14); Kamath (1989:24); Kelly (1982:44-49); Maness and Henderson (1989:19); Richards and Laughlin (1980:33); Shulman and Dambolena (1986:35); and Soenen (1993:53).

7 Net working capital was discussed in section 2.3.2.

8 This measure was discussed in section 4.3.1.3.

the net liquid balance, the net trade cycle and Emery's Lambda.

#### 4.3.3.1 *Cash conversion cycle*

The cash conversion cycle was developed by Richards and Laughlin (1980:33), who extended the traditional static balance sheet analysis of potential liquidation value coverage to include income statement measures. In particular, accounts receivable and inventory turnover measures were included, with the purpose of arriving at a yardstick that would emphasise a going-concern approach to liquidity management. Based on the working capital cycle concept discussed in section 2.3.3, the cash conversion cycle is the net time interval between cash expenditures on productive resources and cash receipts from accounts receivable collections (Scherr 1989:356).

In practice, the cash conversion cycle may be computed as follows: the average collection period of accounts receivable<sup>9</sup> is added to the average age of the inventory; the sum of the two statistics represents the firm's operating cycle, from which the average payment period is subtracted. In this way, the working capital cycle is quantified to portray the residual time interval for which nonspontaneous financing needs to be negotiated in order to compensate for the unsynchronised nature of the firm's working capital investment flows (Richards & Laughlin 1980:34).

Although several authors<sup>10</sup> are of the opinion that the cash conversion cycle is a more accurate measure of the firm's overall liquidity than the traditional current ratio and acid test ratio, Scherr (1989:357) points out that cash, the most liquid of the current assets, is not involved in the calculation of the cash conversion cycle. Gentry et al (1990:90) argue that the cash conversion cycle concentrates on the length of time funds are tied up in the working capital cycle, and does not consider the amount of funds committed to a product as it moves through the cycle. In an attempt to overcome this shortfall, they developed the weighted cash conversion cycle.

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9 This is expressed in days.

10 These authors are Kamath (1989:24); Scherr (1989:357); and Soenen (1993:53).

#### **4.3.3.2      *Weighted cash conversion cycle***

The weighted cash conversion cycle considers both the timing and amount of funds used in each segment of the working capital cycle. In other words, it measures the weighted number of days funds are tied up in accounts receivable, inventories and accounts payable, minus the weighted number of days cash payments are deferred to suppliers. The weight used for the adjustment is the value of the amount of cash tied up in each component divided by the final value of the product.

The weighted cash conversion cycle is developed in two stages. The first stage determines the number of days funds are tied up in raw materials, work-in-progress, finished goods and accounts receivable, which gives the weighted operating cycle. The second stage involves deducting from the weighted operating cycle the number of days that accounts payable are deferred, thereby arriving at the weighted cash conversion cycle.

The cash conversion cycle approach does not decompose inventories into its three component parts, making the measure not directly comparable to the sum of the number of days funds are tied up in the three inventory components in the weighted operating cycle. In contrast, the weighted cash conversion cycle combines the weighted information regarding purchases, production, distribution and accounts receivable less accounts payable, thus focusing attention on the real funds commitment to the total working capital process (Gentry et al 1990:90-99).

However, the external analyst does not readily have access to information on the firm's raw material consumption or the exact date payments are made to suppliers. This limits the practical application of the weighted cash conversion cycle as an aggregate summary measure of liquidity to the internal management of the firm under consideration.

#### **4.3.3.3      *Comprehensive liquidity index***

The comprehensive liquidity index is a liquidity-weighted version of the current ratio developed by Melnyk and Berati (Scherr 1989:357-372). Instead of viewing all current

assets and liabilities as having the same liquidity, the measure overcomes this problem by weighting each current asset and liability based on its nearness to cash. The weighting is done by multiplying the monetary value of each current asset or liability by one minus the inverse of the asset or liability's turnover ratio. Where more than two turnovers are required to generate cash from the asset, the inverse of each of these ratios is deducted, and the results added for all the current assets and liabilities. The added totals depict liquidity-adjusted measures of total current assets and liabilities. In this way the current ratio can be computed, based on the adjusted values for current assets and liabilities.

#### **4.3.3.4      *Net liquid balance***

The net liquid balance approach, applied by Shulman and Dambolena (1986:35-38), differentiates operational assets from liquid assets in an attempt to measure the true liquid balance of financial assets after operational needs have been met. The three components of this approach are net current liquid financial accounts, or net liquid balance; net current operating accounts, or working capital requirements; and net long-term accounts, or net working capital.

The net liquid balance is the difference between net working capital and working capital requirements. Net working capital is defined as current assets minus current liabilities, or as long-term debt and equity minus net fixed assets. The latter definition, according to the authors, will provide analysts with insight into the impact that changes in long-term asset and liability and equity accounts have on the current asset and liability accounts. Working capital requirements - that is, spontaneous items associated exclusively with the operating cycle of production, procurement and sales - consist of the difference between current operational requirements, namely accounts receivable, inventories and prepaid expenses, and current operational resources, namely accounts payable and accruals. Since the spontaneous items varying directly with sales include only the working capital requirements and retained earnings, all other accounts are assumed to be constant in the short run.

A positive net liquid balance would indicate the true liquid surplus of a firm, while a negative net liquid balance would indicate a dependence on short-term external funding.

The net liquid balance divided by total assets could be regarded as a relative measure of liquidity. This measure indicates the firm's percentage of net liquid financial assets, and can be used as a comparative yardstick, from an integrative balance sheet approach, among different firms and industries (Shulman & Cox 1985:65-66)

#### 4.3.3.5 *Net trade cycle*

The net trade cycle, similar to the cash conversion cycle, measures liquidity on a flow basis. Where the measure differs from the cash conversion cycle, instead of computing number of days of cost of goods sold in inventory and number of days of purchases in accounts payable, the net trade cycle calculates days of sales in both (Kamath 1989:26). All elements are therefore expressed in terms of 'number of days sales', hence increasing uniformity and simplicity of calculation (Bernstein 1989:536-538).

#### 4.3.3.6 *Lambda*

In an effort to find a liquidity measure that would provide an indication of the adequacy of the liquid reserves of a firm, Emery (1984:25-32) developed a liquidity index called Lambda. Lambda is defined as initial cash reserves<sup>11</sup> plus total net cash flows<sup>12</sup> divided by the uncertainty about cash flows during the forecast period. In a nutshell, Lambda is the ratio of cash flow resources to potential cash flow requirements. The larger the value of Lambda, the more liquid the firm.

According to Beyer (1988:14-15), Lambda as a liquidity measure has the advantages that it is readily adaptable to forecasts, is easy to apply and is relevant to constantly changing cash flows. The disadvantage for external analysts is that because of the nature of the information the measure requires, Lambda can be applied as a tool for improved financial control by internal management only.

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11 By this is meant cash plus temporary investments plus unused credit at the beginning of the forecast period.

12 In other words, total receipts less total disbursements for the forecast period.

#### 4.4 RECOGNISED MEASURES OF RETURN

The concept of profitability or return implies that the firm's operations will increase the wealth of the owners (Kelly 1982:42) and the measurement of return is regarded as the definitive test of management's effectiveness. Methods for measuring corporate return are numerous and varied, and it is difficult for any one measure to entirely reflect financial performance (Soenen 1993:55). Gitman (1994:125) and Gup (1987:325) group measures of return according to measures relating to sales, assets and equity. In this way, measures of return allow the evaluation of the firm's earnings with respect to a given level of sales, a certain level of assets, and the owners' investment.

##### 4.4.1 Measures of return relating to sales

Measures of return relating to sales are concerned with the expression of income statement items, namely total revenue and expenses, as a percentage of sales. Two such measures are operating income margin and net income margin.

The operating income margin, computed by dividing operating income by sales, is a reflection of the 'pure profits' earned on each rand of sales. Operating profits are pure in the sense that they are not affected by the means of financing used to generate the sales, and exclude expenses such as interest payments (Gup 1987:325).

The net income margin, computed by dividing net income by sales, is the percent of profit earned for each rand of sales after all expenses, including interest and taxes, have been deducted. The higher the margin, the better, with margins differing considerably from industry to industry (Gitman 1994:127).

##### 4.4.2 Measures of return relating to assets

Measures of return relating to assets are an indication of management's overall effectiveness in generating income with its available assets. Two such measures are operating return on assets and return on investment.

The operating return on assets is computed by dividing operating income before interest and taxes by total assets. This measure reflects the return on total assets employed without any consideration of how they were financed, and as such, is an aggregate indicator of management's productivity.

Return on investment, computed by dividing net income by total assets, is a refined version of the previous measure, taking interest and taxes into account. It reflects the impact of debt financing on the firm's profitability, and represents an overall measure of management's effectiveness in generating net income with total assets employed.

#### 4.4.3 Measures of return relating to equity

Measures of return relating to equity facilitate the evaluation of the firm's earnings with respect to a given level of owners' investment. The most well-recognised measure in this regard is return on equity.

Return on equity, calculated by dividing net income by total shareholders equity, measures the rate of return on the owners'<sup>13</sup> investment. Brigham and Gapenski (1993:690) regard the return on equity as the return to ordinary shareholders only, since preference shareholder claims can be viewed as creditors' claims rather than owners' claims. The ratio would then be net income available to ordinary shareholders divided by ordinary shareholders' funds.

#### 4.5 SUMMARY

The purpose of this chapter was to attain the third goal of the study, namely the identification in the literature of traditional and alternative measures of liquidity, and recognised measures of return. The risk-return trade-off served as an introduction to the components of liquidity and return in the management of working capital.

The liquidity component was discussed in terms of traditional liquidity ratios, their shortcomings and alternative measures of liquidity. Traditional liquidity ratios can be

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13 Owners refer to both preference and ordinary shareholders.

grouped according to whether they measure working capital position, working capital activity or leverage. The best-recognised working capital position ratios are the current ratio and the quick ratio. Frequently cited working capital activity ratios are inventory turnover, accounts receivable turnover, accounts payable turnover and sales to net working capital. The leverage measures considered are long-term loan capital divided by net working capital, accounts receivable divided by accounts payable and total current liabilities divided by gross funds flow.

Shortcomings of traditional liquidity measures are well documented in the literature. The most frequently cited shortcomings are the static nature of ratio analysis, the refutability of traditional measures to accurately estimate future cash flow magnitudes and patterns, and their dependence on the liquidation concept rather than on a going-concern approach.

In an attempt to overcome the shortcomings of traditional ratio analysis, several alternative liquidity measures have been developed. The cash conversion cycle, the weighted cash conversion cycle, the comprehensive liquidity index, the net liquid balance, the net trade cycle and Emery's Lambda are the best documented of these alternative measures.

The element of return implies that the firm's operations will increase the wealth of the owners, and recognised measures of return can be grouped according to measures relating to sales, assets and equity. Hereto the operating income margin, the net income margin, the operating return on assets, return on investment and return on equity were discussed.

By attaining the first three goals of the study as set out in section 1.5, a suitable literature framework has been established to serve as a departure point for the empirical research. The next chapter will look at the method of research to be followed in this study of the association between traditional and alternative liquidity measures and the measures of return of South African listed industrial firms.

PART III

EMPIRICAL STUDY

## CHAPTER 5

### RESEARCH METHODOLOGY

#### 5.1 INTRODUCTION

The central objective of the study is to investigate the association between traditional and alternative working capital measures, and the returns of South African industrial firms. In this respect, a theoretical base was developed in the previous chapters, to serve as a foundation of reference for the empirical research.

At this point, it is necessary to identify the two separate stages of data analysis, namely data exploration and data confirmation, both of which need to be addressed in the investigation of the association between working capital measures and returns. Data exploration attempts to recognise in the database nonrandom patterns or structures requiring explanation, and seeks methods to discern undetected paradigms in the data. These methods are commonly characterised by their accent on the prominence of visual displays and graphical representations (Everitt & Dunn 1991:6). Data confirmation, in contrast, encompasses the use of multivariate techniques to test (confirm) prespecified relationships (Hair, Anderson, Tatham & Black 1992:428).

The objective of this chapter is to describe the scientific data exploration undertaken in order to facilitate the subsequent data confirmation step required to meet the study objectives. This chapter will cover the following aspects in particular:

- \* the data source consulted
- \* the nature of the participating firms

- \* the variables included in the study
- \* the overall descriptive statistics of firms and variables
- \* the decision to use the mean of 10 years per firm
- \* data transformation

## 5.2 THE DATA SOURCE

Data used in the empirical study were acquired from the University of Pretoria's Bureau of Financial Analysis (BFA). The BFA database contains comprehensive financial information on firms listed on the Johannesburg Stock Exchange (JSE), and produces standardised annual financial statements according to the requirements of the Companies Act of 1973. These include standardised balance sheets and income statements, and other standardised sundry information.

## 5.3 NATURE OF THE PARTICIPATING FIRMS

Data from the financial statements of all industrial firms listed on the Johannesburg Stock Exchange for the years 1984 to 1993<sup>1</sup> formed the basis of the calculations. Only firms listed for all 10 years were included, in this way ensuring that 10 continuous years of observations for each participating firm would be available. A period of longer than 10 years was initially considered, but this would have meant the exclusion of too many firms.

Sixty pyramid firms, of which the sole or main assets are investments in other listed South African firms, were deleted from the data set. As such, pyramid firms hold no current assets and their contribution to local working capital management is regarded as insignificant. Twenty non-South African firms, trading in foreign countries, were also deleted. These firms were removed on the assumption that they plausibly operate in different markets to local industrial firms. The exclusion of pyramid and foreign firms<sup>2</sup> is consistent with previous research considerations involving listed South African

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1 1993 was the most current year of complete financial statement data when the exploratory study was conducted.

2 Appendix A lists the details of the pyramid and foreign firms excluded.

industrial firms. (see, eg, Jordaan, Smit & Hamman 1994:67). These deletions left a data set of 135 firms, the nature of which is reflected in table 5.1, by number of listed industrial firms per sector.

TABLE 5.1  
NATURE OF PARTICIPATING FIRMS

| SECTOR CODE | SECTOR DESCRIPTION              | NO. OF FIRMS | %    |
|-------------|---------------------------------|--------------|------|
| 15          | Industrial holding              | 22           | 16,3 |
| 20          | Beverages, hotels and leisure   | 3            | 2,2  |
| 21          | Building and construction       | 12           | 8,9  |
| 22          | Chemicals and oils              | 7            | 5,2  |
| 23          | Clothing, footwear and textiles | 15           | 11,1 |
| 25          | Food                            | 13           | 9,6  |
| 26          | Electronics                     | 10           | 7,4  |
| 27          | Furniture and household goods   | 6            | 4,5  |
| 28          | Engineering                     | 12           | 8,9  |
| 29          | Motor                           | 6            | 4,5  |
| 30          | Paper and packaging             | 8            | 5,9  |
| 31          | Pharmaceutical and medical      | 3            | 2,2  |
| 32          | Printing and publishing         | 4            | 3,0  |
| 33          | Retailers and wholesalers       | 11           | 8,1  |
| 35          | Steel and allied                | 1            | 0,7  |
| 37          | Transportation                  | 2            | 1,5  |
|             | Total                           | 135          | 100  |

Source: BFA database

Table 5.1 indicates that most of the participating firms are from the industrial holding sector (16,3 %), followed by clothing, footwear and textiles, with 11,1 percent of the firms. The steel and allied sector comprise one, and the transportation sector two firms only. To augment perspicuity, the sum of participating firms per sector as a percentage of all industrial firms listed at 31/12/93 was computed, and the details captured in table 5.2.

TABLE 5.2  
PARTICIPATING FIRMS AS A PERCENTAGE OF ALL INDUSTRIAL FIRMS LISTED AT  
31/12/93

| CODE | SECTOR DESCRIPTION            | LISTED FIRMS | PARTICIPATING FIRMS | %  |
|------|-------------------------------|--------------|---------------------|----|
| 15 * | Industrial holding            | 54           | 22                  | 41 |
| 20   | Beverages, hotels and leisure | 21           | 3                   | 14 |
| 21 * | Building and construction     | 24           | 12                  | 50 |
| 22 * | Chemicals and oils            | 11           | 7                   | 64 |
| 23 * | Clothing, footwear etc        | 33           | 15                  | 45 |
| 25 * | Food                          | 25           | 13                  | 52 |
| 26   | Electronics                   | 37           | 10                  | 27 |
| 27 * | Furniture and household goods | 11           | 6                   | 55 |
| 28 * | Engineering                   | 28           | 12                  | 43 |
| 29 * | Motor                         | 14           | 6                   | 43 |
| 30 * | Paper and packaging           | 15           | 8                   | 53 |
| 31   | Pharmaceutical and medical    | 12           | 3                   | 25 |
| 32   | Printing and publishing       | 11           | 4                   | 36 |
| 33   | Retailers and wholesalers     | 46           | 11                  | 24 |
| 35   | Steel and allied              | 3            | 1                   | 33 |
| 37   | Transportation                | 9            | 2                   | 22 |
| 46   | Development capital           | 17           | -                   | 0  |
|      | Total                         | 371          | 135                 |    |

Source: BFA database

Table 5.2 indicates that nine of the sectors<sup>3</sup>, exemplifying all listed firms at 31/12/93, are more than 40 percent represented by the firms participating in the study. The other eight sectors indicate weaker representation, with no development capital firms participating, and 14 percent representation of the beverages, hotels and leisure sector. The participating firms, however, do represent all firms listed for the years 1984 to 1993 on the JSE, excluding pyramids and foreign firms.

3 The sector codes are marked with an \*.

#### 5.4 VARIABLES INCLUDED IN THE STUDY

The following financial data (labelled variables R1 to R25 for the purposes of the study) were extracted from the BFA database for every participating firm for each year from 1984 to 1993:

|   |     |  |
|---|-----|--|
| * | R1  | current assets as a percentage of total assets           |
| * | R2  | current liabilities as a percentage of total liabilities |
| * | R3  | turnover   |
| * | R4  | income after taxation                                    |
| * | R5  | total assets   |
| * | R6  | current ratio  |
| * | R7  | quick ratio  |
| * | R8  | net working capital                                      |
| * | R9  | inventory turnover                                       |
| * | R10 | accounts receivable turnover                             |
| * | R11 | accounts payable turnover                                |
| * | R12 | long-term loan capital divided by net working capital    |
| * | R13 | accounts receivable divided by accounts payable          |
| * | R14 | total current liabilities divided by funds flow          |
| * | R15 | cash conversion cycle                                    |
| * | R16 | comprehensive liquidity index                            |
| * | R17 | net liquid balance                                       |
| * | R18 | net trade cycle  |
| * | R19 | operating income margin                                  |
| * | R20 | net income margin  |
| * | R21 | operating return on assets                               |
| * | R22 | return on investment                                     |
| * | R23 | return on equity   |
| * | R24 | net liquid balance divided by total assets               |
| * | R25 | turnover divided by net working capital                  |

Each of the above variables has been previously identified in the literature study. Variables

R1 and R2 are descriptive financial ratios derived for comparative statistics<sup>4</sup>. R3, R4, R5, R8 and R17 are rand value variables, used in subsequent liquidity ratio derivations.

The traditional measures of liquidity to be used as independent variables in testing for association with the dependent variables are R6, R7, R9-R14, and R25. The first two variables (R6 and R7) are working capital position ratios described in section 4.3.1.1; R9, R10, R11 and R25 are working capital activity ratios covered in section 4.3.1.2; and R12, R13 and R14 embody the leverage measures of section 4.3.1.3.

The alternative liquidity measures to be used as independent variables in testing for association with the dependent variables are R15, R16, R18 and R24. R15 is explained in section 4.3.3.1, R16 in section 4.3.3.3, R18 in section 4.3.3.5 and R24 is the net liquid balance in section 4.3.3.4 converted into a relative measure by dividing it by total assets (variable R5).

The dependent variables are R19-R23, representing the measures of return for the industrial firms. R19 and R20 are found in section 4.4.1, R21 and R22 in section 4.4.2 and R23 in section 4.4.3.

The 25 variables derived for each of the 135 participating firms for 10 years postulated a potential data set of 33 750 observations. Turnover figures were not procurable for all firms for all 10 years, which meant that some observations, reliant on turnover figures, displayed missing values. Other reasons for missing values were, for example, where Pick 'n Pay had a negative value for net current assets in 1993, and the R12 variable displayed a missing value. In total, 31 949 observations were recorded<sup>5</sup>.

Evidence of the character of the distributions of the variables is important since it guides the choice of statistical tools (Buijink & Jegers 1986: 337). The Statistical Analysis

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4 Table 1.1 contains details of current assets as a percentage of total assets (R1), and current liabilities as a percentage of total liabilities (R2) for South African industrial firms.

5 One thousand, eight hundred and one observations exhibited missing values. Appendix B comprises details of the number of observations captured per variable for the 10 years.

System (SAS)<sup>6</sup> was used to discern the distributional paradigms in the data. The SAS PROC UNIVARIATE procedure calculates values such as the arithmetic mean, median and standard deviation, and plots a histogram, boxplot and normal probability plot of the distributional patterns of the data. PROC UNIVARIATE was run for each of the 25 variables

- \* at the industry level over 10 years (generating 25 histograms)
- \* per sector whilst aggregated over time (generating 400 histograms)
- \* per year whilst aggregated over sectors (generating 250 histograms)

Insufficient observations precluded exploratory analysis of variables per sector per year. The initial data analysis constituted an examination of a total of 675 histograms and the arithmetic mean<sup>7</sup>, median, standard deviation<sup>8</sup>, range, minimum and maximum values, and the skewness and kurtosis coefficients of each variable. Figure 5.1 arrays examples of histograms, boxplots and normal probability plots typical of the raw data used in this study<sup>9</sup>.

Figures 5.1(a), 5.1(b) and 5.1(c) reflect the distribution of variables R6 (current ratio), R9 (inventory turnover) and R12 (long-term loan capital divided by net working capital), indicating highly irregular distributional patterns typical of many of the raw data variables. Figures 5.1(d), 5.1(e), and 5.1(f), reflecting the distribution of variables R15 (cash conversion cycle), R19 (operating income margin) and R23 (return on equity), in contrast, display greater symmetry in the distributions, albeit with high kurtosis. The peakedness of the data is a characteristic pertaining to all the variables, indicating that the majority of observations are concentrated in a common band. Another feature of the data set is the pervasion of positive skewness, which may be ascribed, for most variables, to an effective lower boundary of zero, but an infinite upper ceiling. The distributional patterns of the data are further discussed in section 5.6.

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6 Appendix E contains details of the SAS program commands used in the study.

7 The arithmetic mean is hereafter referred to as AM, where appropriate.

8 The standard deviation is hereafter referred to as SD, where appropriate.

9 It was an arbitrary decision to include in figure 5.1 the first of each of the three groups of working capital traditional measures, namely R6 (working capital position), R9 (working capital activity), and R12 (leverage); and to include R15, the first of the alternative working capital measures. Analogously, R19 and R23, the first and last of the return measures, were arbitrarily included in figure 5.1.

FIGURE 5.1 (a)  
 HISTOGRAM, BOXPLOT AND NORMAL PROBABILITY PLOT FOR VARIABLE R6 (THE CURRENT RATIO)

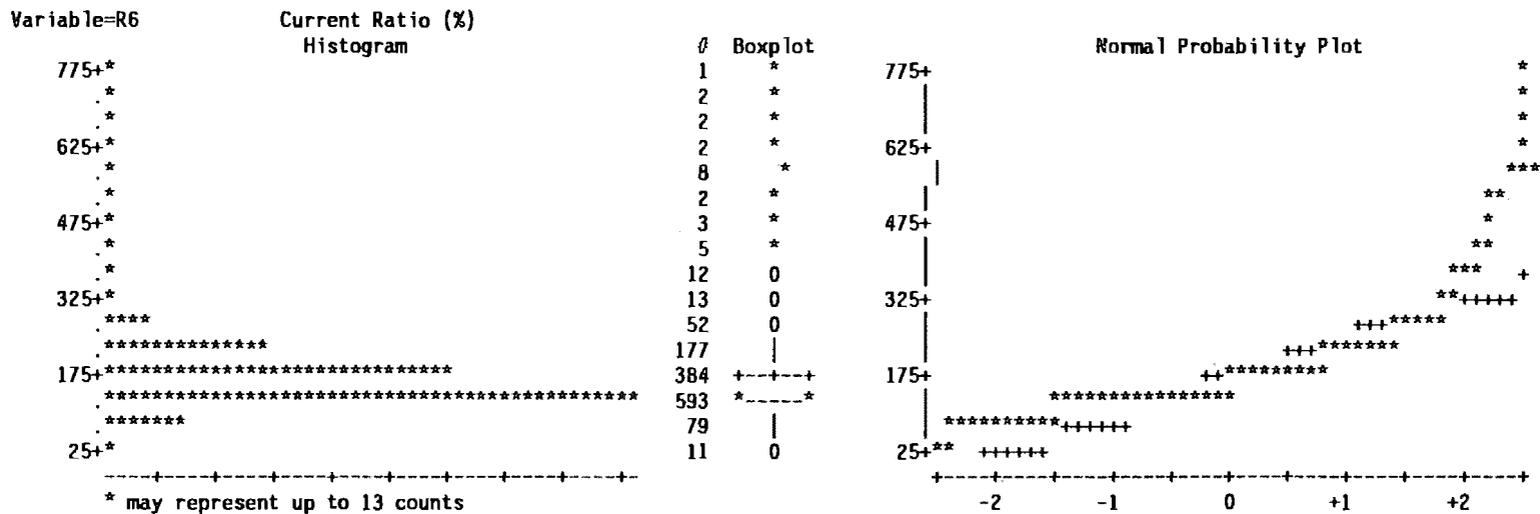


FIGURE 5.1 (b)  
 HISTOGRAM, BOXPLOT AND NORMAL PROBABILITY PLOT FOR VARIABLE R9 (INVENTORY TURNOVER)

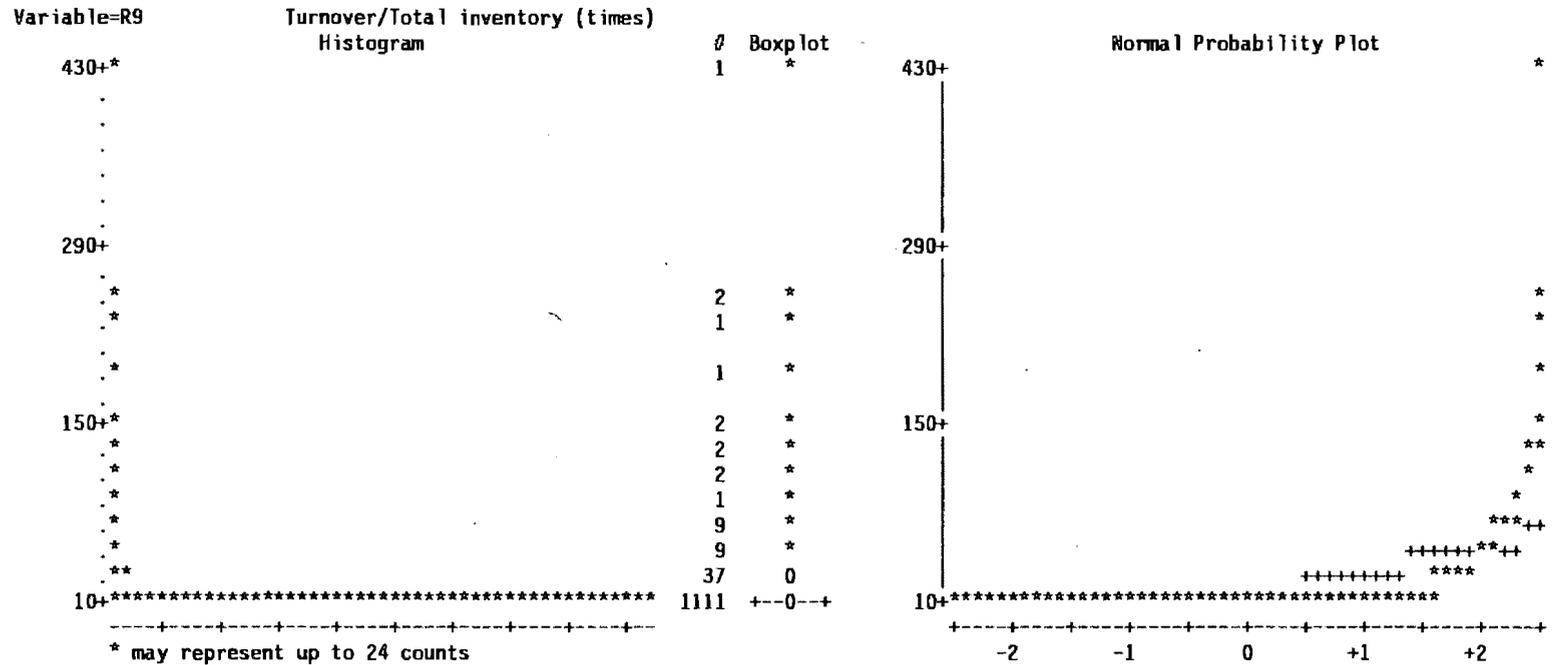


FIGURE 5.1 (c)  
 HISTOGRAM, BOXPLOT AND NORMAL PROBABILITY PLOT FOR VARIABLE R12 (TOTAL LONG-TERM LOAN CAPITAL DIVIDED BY NET WORKING CAPITAL)

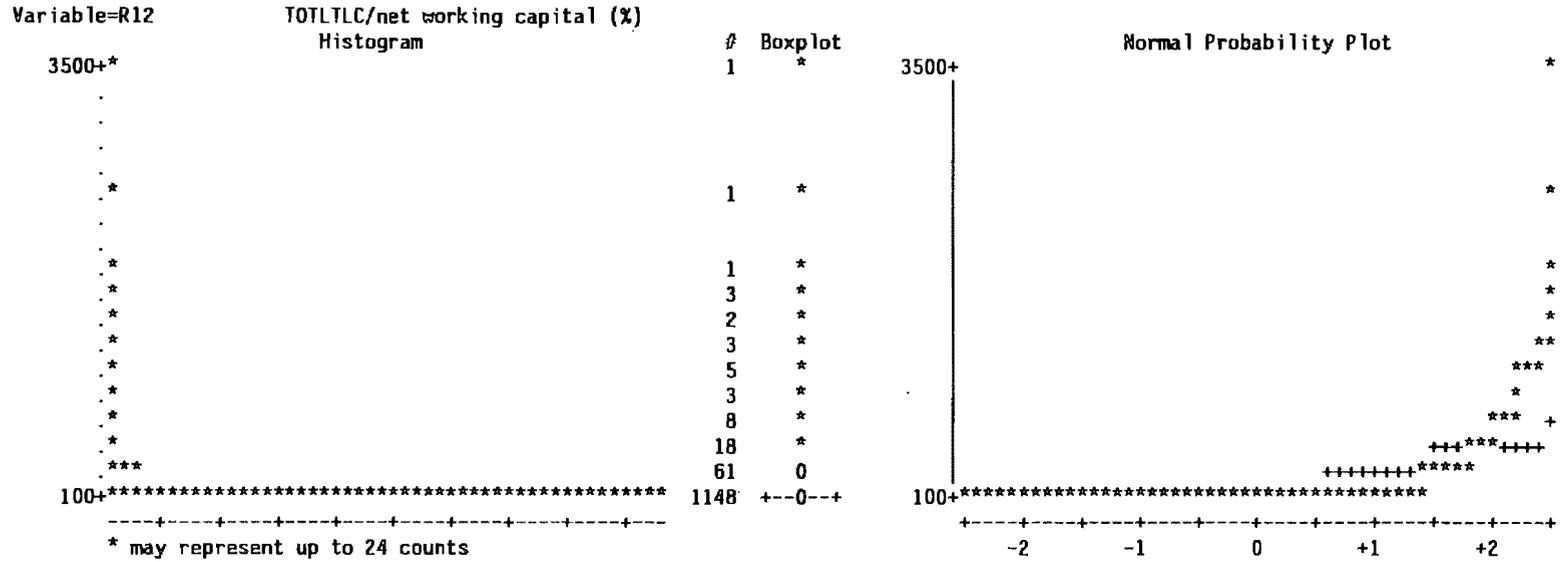


FIGURE 5.1 (d)  
 HISTOGRAM, BOXPLOT AND NORMAL PROBABILITY PLOT FOR VARIABLE R15 (THE CASH CONVERSION CYCLE)

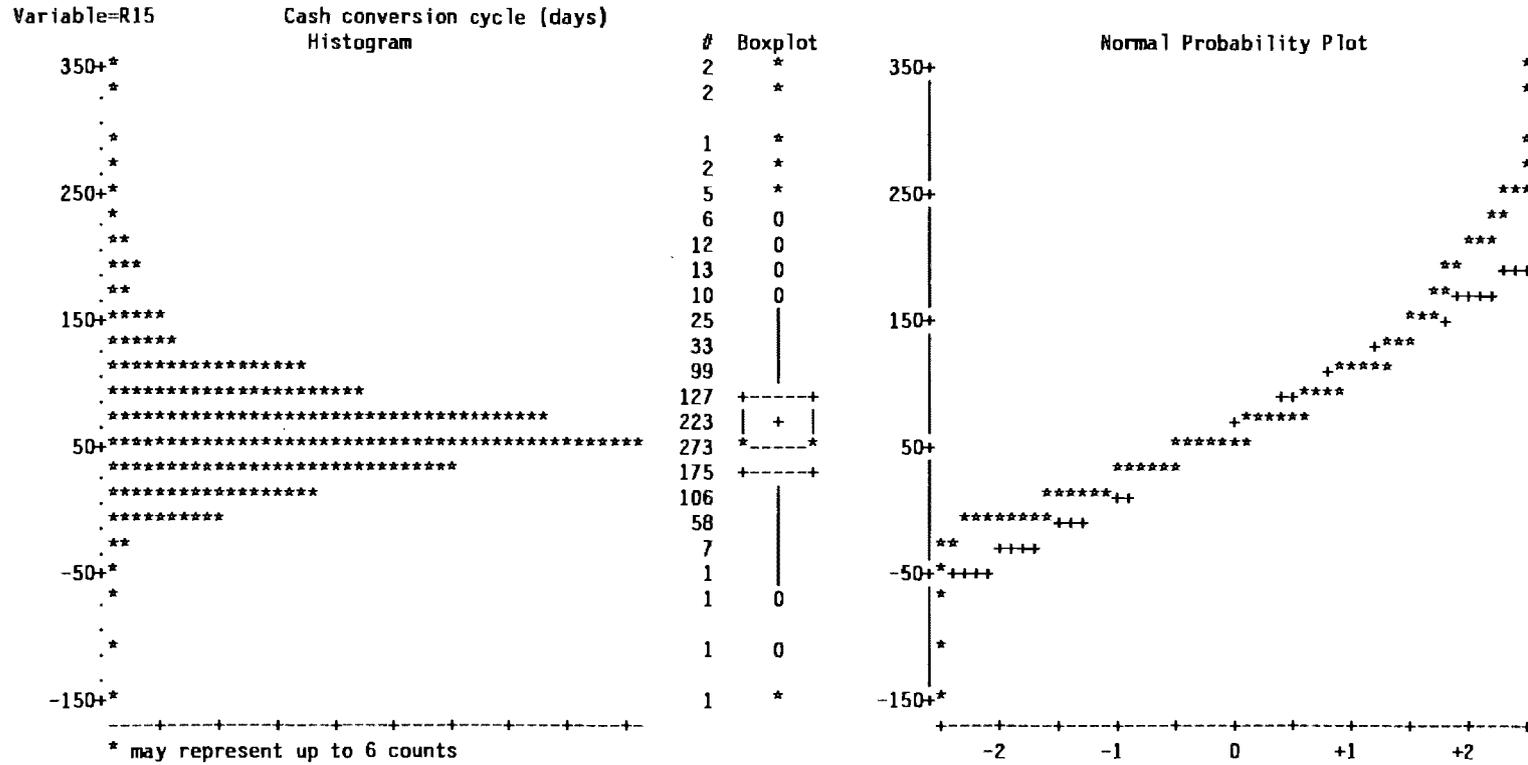


FIGURE 5.1 (e)  
 HISTOGRAM, BOXPLOT AND NORMAL PROBABILITY PLOT FOR VARIABLE R19 (THE OPERATING INCOME MARGIN)

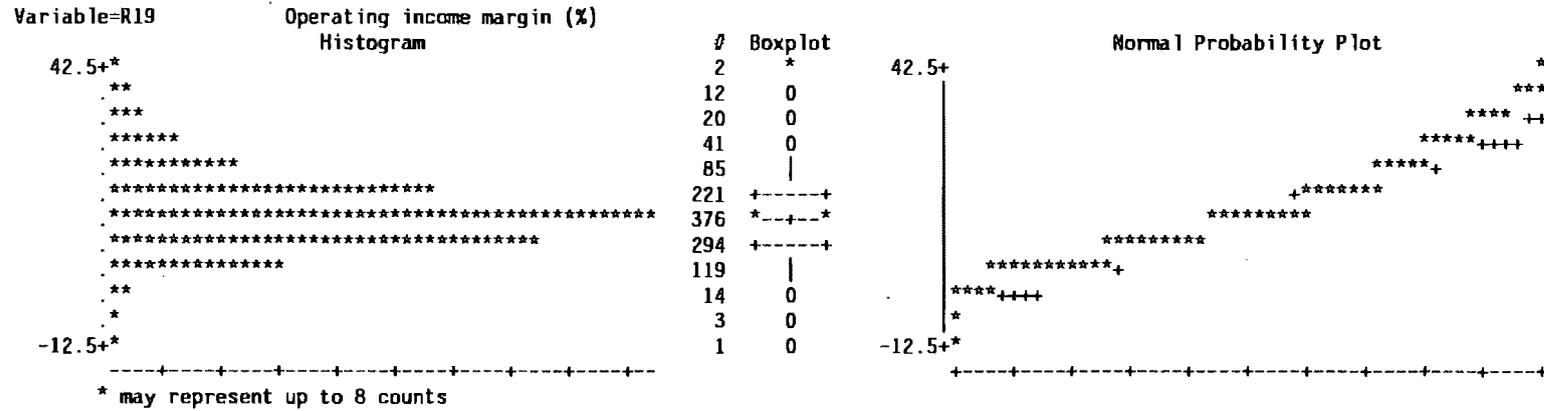
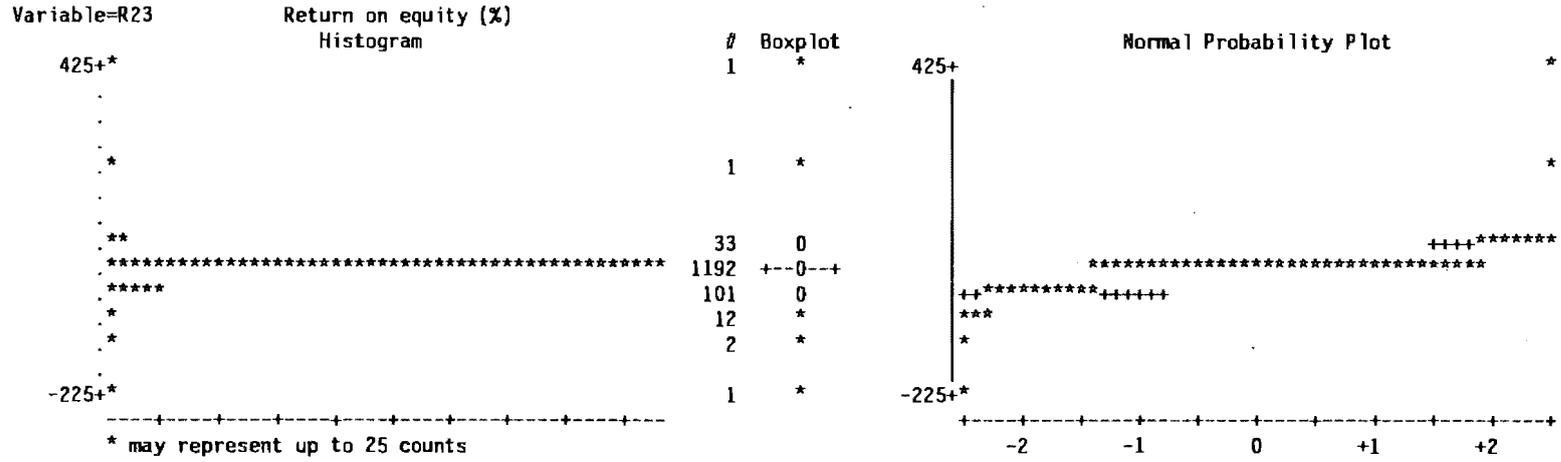


FIGURE 5.1 (f)  
 HISTOGRAM, BOXPLOT AND NORMAL PROBABILITY PLOT FOR VARIABLE R23 (RETURN ON EQUITY)



The purpose of the examination of the raw data histograms was to identify general patterns in the data set of 31 949 observations, with due regard for the following:

In all situations, the analyst is encouraged to delete truly exceptional observations, but must guard against deleting observations that, while different, are still representative of the population. Remember that the objective is ensuring the most representative model for the sample data so that it will best reflect the population from which it was drawn (Hair et al 1992:51).

Accordingly, with due circumspection, 24 observations were excluded from the data set<sup>10</sup>. The basis for exclusion was abnormal causes, for instance, the realisation of extraordinary profits or losses, leaving a total of 31 925 observations for use in further exploratory and confirmatory research. Outliers in the distribution were not eliminated, as these represent the distinctive elements of the data set being studied, and can only be identified with respect to a specific regression model because of their large residual values (Hair et al 1992:49).

## 5.5 OVERALL DESCRIPTIVE STATISTICS OF FIRMS AND VARIABLES

This section presents some descriptive measures examined in the exploratory analysis of the data set of 31 925 observations relating to the participating firms and their variables. These descriptive measures are those items calculated by the SAS PROC UNIVARIATE procedure, namely arithmetic means, medians and measures of variance of the data. The first two variables, R1 and R2, receive particular attention here, as their arithmetic means are analogous to the 'average' measure in table 1.1 of the study. Thereafter, temporal trends in the independent and dependent variables are examined.

### 5.5.1 Univariate descriptive statistics for R1 and R2

Descriptive measures of the variables R1 (current assets as a percentage of total assets) and R2 (current liabilities as a percentage of total liabilities) are presented at the industry

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10 See appendix C for a list of observations excluded.

level (aggregated over time and sector)(table 5.3), per sector (table 5.4), and as trends over the 10 years (fig 5.2).

**TABLE 5.3**  
**CURRENT ASSETS AS A PERCENTAGE OF TOTAL ASSETS (R1), AND CURRENT LIABILITIES AS A PERCENTAGE OF TOTAL LIABILITIES (R2), FOR ALL PARTICIPATING FIRMS AGGREGATED OVER TIME AND SECTOR**

|                    | R1<br>(CA % TA) | R2<br>(CL % TL) |
|--------------------|-----------------|-----------------|
| Arithmetic mean    | 60              | 81              |
| Standard deviation | 20              | 18              |
| Median             | 60              | 85              |

The arithmetic mean of current assets as a percentage of total assets (R1) for all participating firms, aggregated over time and sector, is 60 percent. This is higher than the 46 percent average recorded in table 1.1, which reflects financial statistics of the first 33 of the *Financial Mail's* (June 1994) top 100 industrial firms. Similarly, the arithmetic mean of current liabilities as a percentage of total liabilities (R2) for all participating firms, aggregated over time and sector, is 85 percent. Again, this average is higher than the 72 percent average found in table 1.1. The connotation follows that current assets and liabilities, on average, form a greater percentage of total assets and liabilities for industrial firms that have been listed for the last 10 years, than for the first 33 of the *Financial Mail's* (June 1994) top 100 industrial firms ranked according to total assets.

Table 5.4 discloses the arithmetic mean (AM), standard deviation (SD) and median (MED) values of current assets as a percentage of total assets (R1) and current liabilities as a percentage of total liabilities (R2) per sector.

TABLE 5.4  
CURRENT ASSETS AS A PERCENTAGE OF TOTAL ASSETS (R1), AND CURRENT  
LIABILITIES AS A PERCENTAGE OF TOTAL LIABILITIES (R2), PER SECTOR

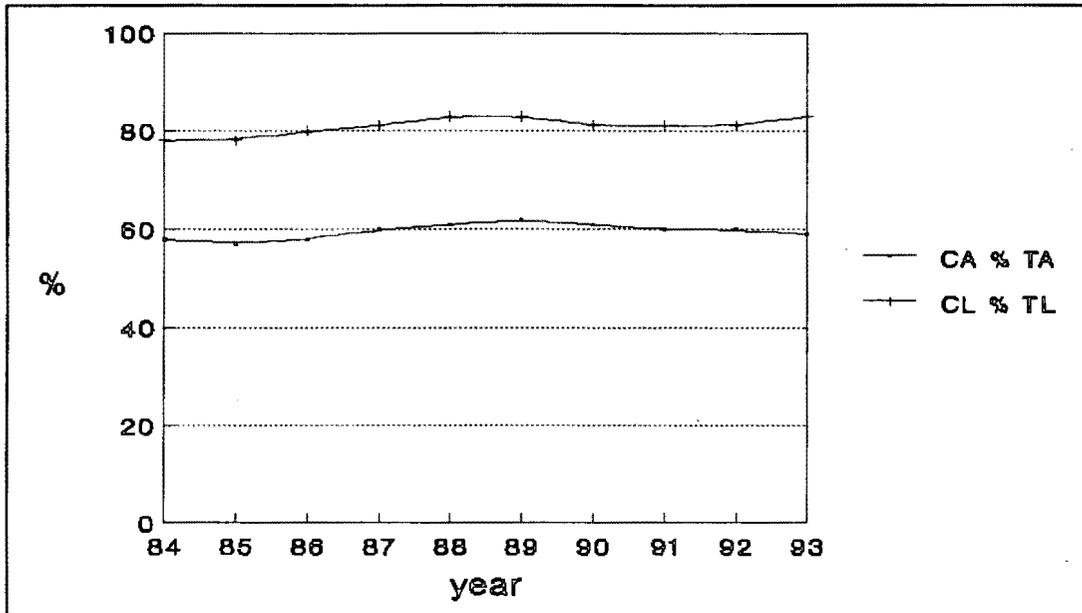
| SECTOR DESCRIPTION         | R1<br>(CA % TA) |    |     | R2<br>(CL % TL) |    |     |
|----------------------------|-----------------|----|-----|-----------------|----|-----|
|                            | AM              | SD | MED | AM              | SD | MED |
| Industrial holding         | 58              | 18 | 60  | 79              | 18 | 83  |
| Beverages, hotels, etc     | 32              | 20 | 31  | 70              | 17 | 69  |
| Building and construction  | 55              | 23 | 51  | 84              | 19 | 93  |
| Chemicals and oils         | 53              | 18 | 54  | 73              | 19 | 75  |
| Clothing, footwear, etc    | 69              | 18 | 76  | 80              | 15 | 83  |
| Food                       | 48              | 19 | 53  | 81              | 14 | 83  |
| Electronics                | 67              | 19 | 69  | 88              | 19 | 97  |
| Furniture and household    | 73              | 18 | 82  | 69              | 23 | 66  |
| Engineering                | 58              | 17 | 59  | 84              | 14 | 88  |
| Motor                      | 68              | 18 | 70  | 82              | 18 | 89  |
| Paper and packaging        | 57              | 20 | 57  | 80              | 20 | 86  |
| Pharmaceutical and medical | 69              | 20 | 72  | 89              | 15 | 100 |
| Printing and publishing    | 52              | 7  | 52  | 89              | 8  | 90  |
| Retailers and wholesalers  | 68              | 18 | 75  | 83              | 13 | 83  |
| Steel and allied           | 35              | 12 | 37  | 79              | 26 | 95  |
| Transportation             | 39              | 9  | 40  | 82              | 19 | 86  |

Table 5.4 shows that, on average, current assets represent 73 percent of the total assets of the all participating firms from the furniture and household goods sector. The highest arithmetic mean value for R2 is shared by the pharmaceutical and medical and printing and publishing sectors where current liabilities, on average, represent 89 percent of their total liabilities, with the former sector also displaying the highest median value (100%). For statistical verification of significant differences between sectors, see section 6.4.

Figure 5.2 represents a simple chart of the arithmetic means of the variables R1 and R2 for all participating firms plotted as a trend over the 10 years. The trends of the arithmetic means of R1 and R2 for all participating firms display temporal consistency, with

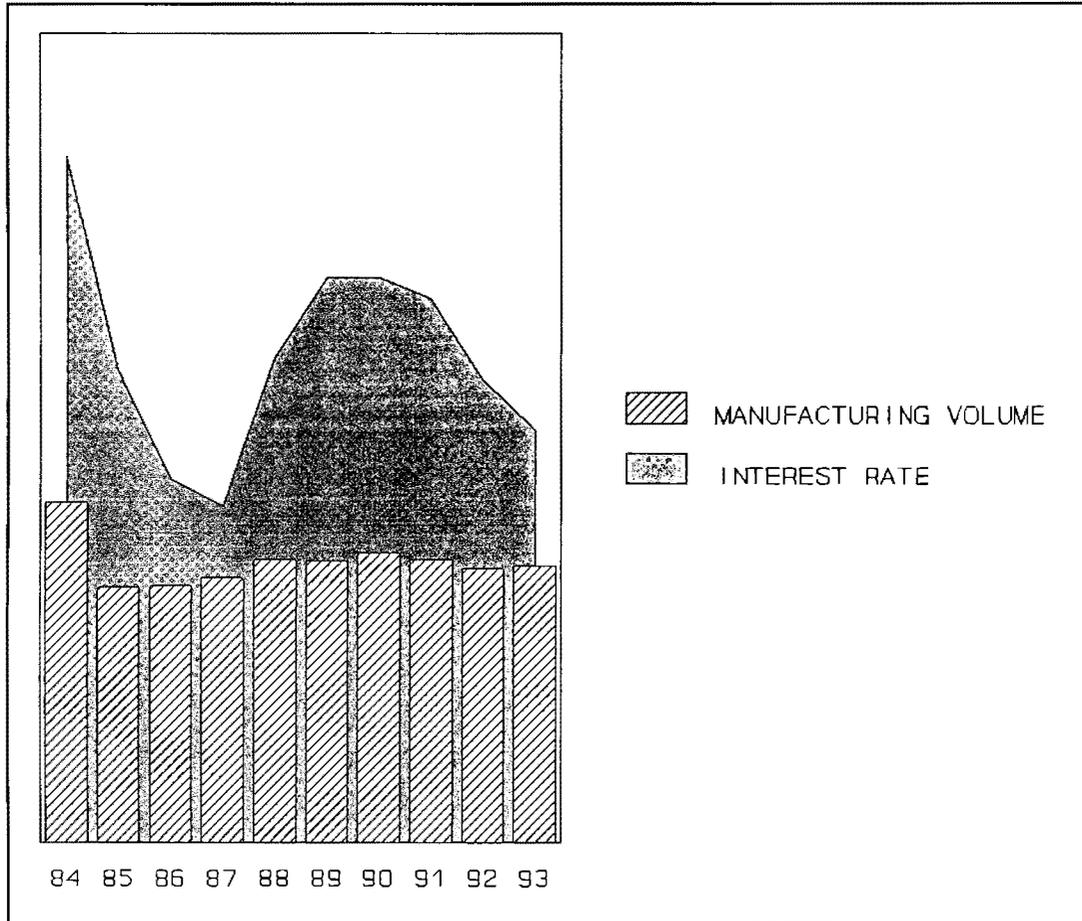
parsimonious peaks in 1988 and 1989.

**FIGURE 5.2**  
**TREND OF THE ARITHMETIC MEANS OF R1 (CURRENT ASSETS AS A PERCENTAGE OF TOTAL ASSETS) AND R2 (CURRENT LIABILITIES AS A PERCENTAGE OF TOTAL LIABILITIES) FOR ALL PARTICIPATING FIRMS PER YEAR**



In the endeavour to explain the temporal trends in figure 5.2, some economic indicators were explored. The economic indicators of average yearly manufacturing volumes and interest rates were extracted for the 10 years under review. Manufacturing volumes were deemed appropriate indicators, considering that the participating firms are all industrial firms, largely involved in the manufacturing process. Other indicators were considered, for example, vehicle sales. However, they followed similar trends to manufacturing volumes, and were therefore not included. Interest rates were considered an important indicator of the cost of short-term finance, with interest rates lagging slightly behind manufacturing volumes. The indicators for the 10 years appear in figure 5.3, exhibiting a temporal pattern, with the indicators moving from a peak in 1984 to a low in 1985 to 1987, followed by a peak in 1988 to 1990.

FIGURE 5.3  
SELECTED ECONOMIC INDICATORS FOR THE 10 YEARS UNDER REVIEW



Source: Pretorius and Corr 1993.

The 1988 to 1990 zenith in figure 5.2 corresponds with the peak in figure 5.3, which occurs in 1988 to 1989. The immediate observation is that current assets as a percentage of total assets increased with the economic upturn, and decreased with a downturn. The same assertion could be made regarding current liabilities as a percentage of total liabilities, indicating, albeit cursorily, that working capital management is under pressure during an economic downturn. However, in order to make meaningful inferences and comparisons with other studies, an extensive time series analysis would need to be undertaken, something which falls outside the scope of this study<sup>11</sup>. The following section examines temporal tendencies in the independent and dependent variables in greater depth.

11 Refer to section 5.6 for further discussion on this.

### 5.5.2 Temporal tendencies in independent and dependent variables

The temporal tendencies in the arithmetic means of the independent and dependent variables for all participating firms were also surveyed. The arithmetic means per year of the current ratio (represented by R6, a traditional measure of working capital position), accounts payable turnover (R11, a traditional measure of working capital activity) and total current liabilities divided by funds flow (R14, a traditional measure of leverage)<sup>12</sup>, and the four alternative liquidity measures, R15, R16, R18 and R24<sup>13</sup>, aggregated over all firms, are shown in table 5.5.

TABLE 5.5  
ARITHMETIC MEAN OF TRADITIONAL AND ALTERNATIVE LIQUIDITY MEASURES  
FOR ALL FIRMS PER YEAR

| YEAR | R6 (%) | R11 (times) | R14 (years) | R15 (days) | R16 (%) | R18 (days) | R24 (%) |
|------|--------|-------------|-------------|------------|---------|------------|---------|
| 1984 | 170    | 7,55        | 5,11        | 72         | 1,35    | 70         | -0,03   |
| 1985 | 167    | 7,81        | 5,92        | 75         | 1,31    | 74         | -0,06   |
| 1986 | 167    | 7,63        | 4,94        | 74         | 1,30    | 71         | -0,04   |
| 1987 | 175    | 7,41        | 4,33        | 66         | 1,40    | 65         | 0,01    |
| 1988 | 166    | 7,09        | 3,79        | 69         | 1,32    | 67         | 0,02    |
| 1989 | 165    | 7,33        | 3,54        | 64         | 1,36    | 63         | 0,01    |
| 1990 | 167    | 7,56        | 4,03        | 66         | 1,50    | 64         | -0,02   |
| 1991 | 158    | 7,19        | 4,98        | 62         | 1,40    | 62         | -0,03   |
| 1992 | 165    | 6,93        | 5,82        | 64         | 1,40    | 63         | -0,01   |
| 1993 | 162    | 6,73        | 5,98        | 60         | 1,40    | 60         | 0,01    |

The arithmetic mean of R6, the current ratio, for all participating firms has, on average, fluctuated by 10 percent between a range of 158 to 175 percent. Similarly, R11, the accounts payable turnover, has fluctuated by 14 percent between a range of 6,73 and 7,81 (times). R14, total current liabilities divided by funds flow, displays temporal fluctuation, averaging at 4,84 years over the period.

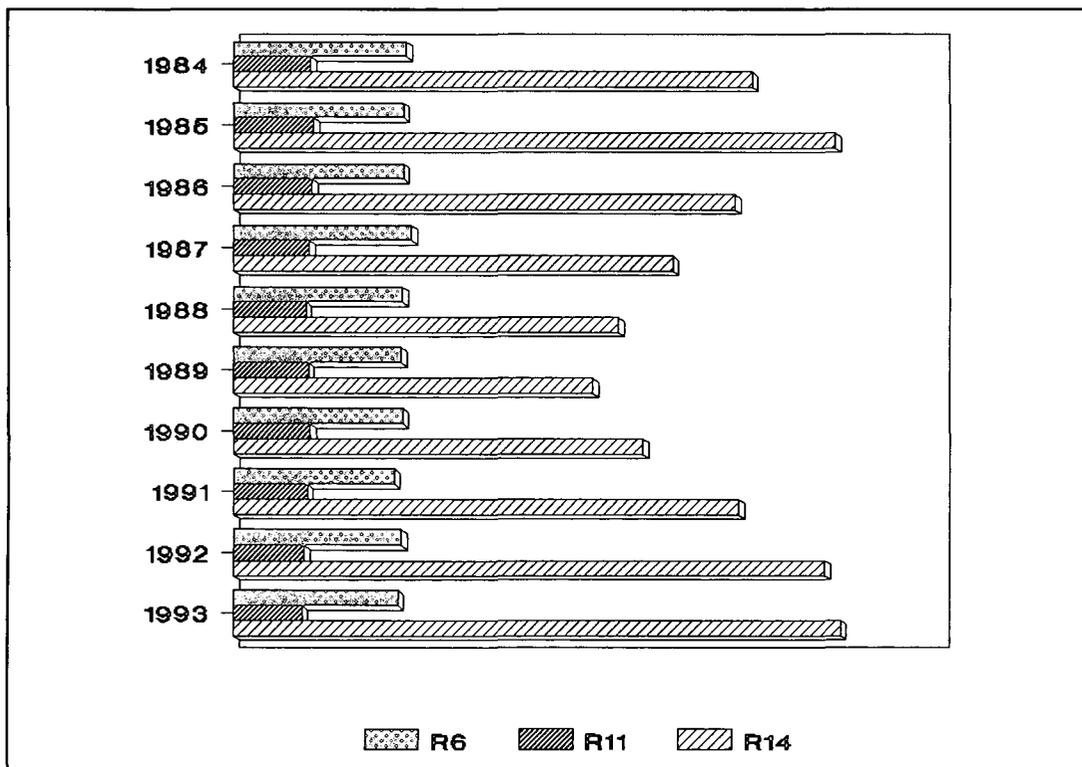
12 These particular traditional measures were selected because of their interesting and contrasting temporal trends.

13 These four measures were selected as they are the four alternative measures to be tested in the empirical study (see sec 4.3.3 in this regard).

Over the 10 years, R15 (the cash conversion cycle) has had a reducing trend, with the average cash conversion cycle of all participating firms 17 percent lower in 1993 than in 1984. R18 (the net trade cycle) also reduced from a high of 74 days in 1985 to a low of 60 days in 1993. R16 (the comprehensive liquidity index) remained fairly stable over the 10 years<sup>14</sup>, with the arithmetic mean marginally higher in 1993 than in 1984 (140% compared to 135%). R24 (the net liquid balance divided by total assets) indicated an oscillating trend over time, averaging at -0,01 percent over the period.

The arithmetic means of the traditional liquidity measures reflected in table 5.5 are graphically represented in figure 5.4, and those of the alternative liquidity measures in figure 5.5.

FIGURE 5.4  
ARITHMETIC MEAN OF TRADITIONAL MEASURES FOR ALL FIRMS PLOTTED OVER TIME



14 This is not altogether surprising, considering that the comprehensive liquidity index (see sec 4.3.3.3) may be considered a liquidity-weighted version of the current ratio, with the latter having displayed reasonable consistency over the 10 years.

Figure 5.4 indicates that of the three traditional measures, R14 (total current liabilities divided by funds flow) graphically reflects the most fluctuation. This fluctuation is perceptible in opposite trends to the economic indicators in figure 5.3, with a nadir in 1988 to 1989. In contrast, R6 (the current ratio) and R11 (accounts payable turnover) manifest temporal consistency.

FIGURE 5.5  
ARITHMETIC MEAN OF ALTERNATIVE MEASURES FOR ALL FIRMS PLOTTED OVER TIME

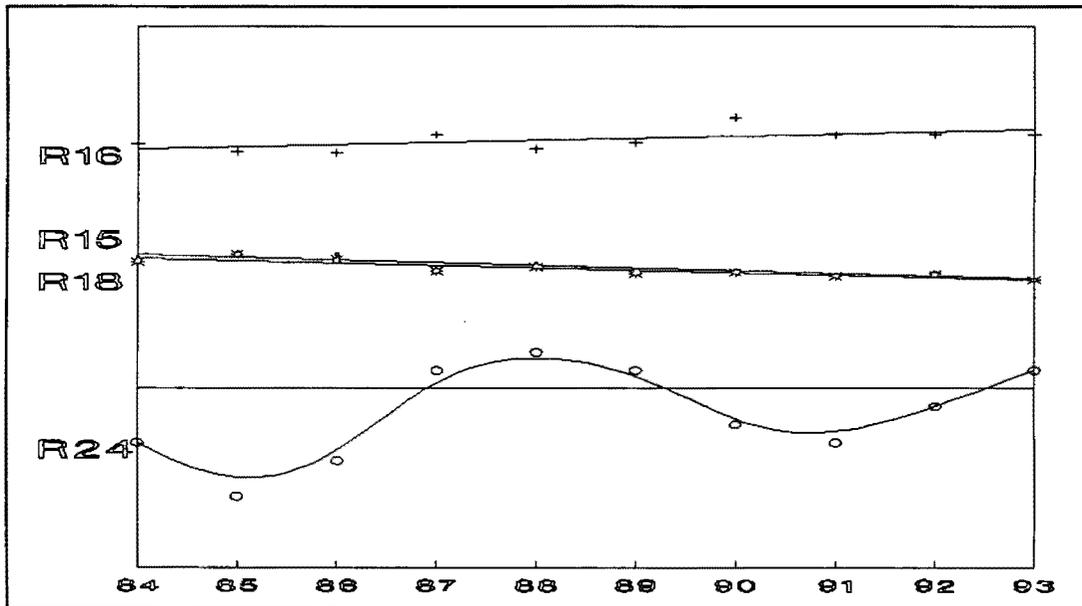


Figure 5.5 exhibits the temporal trends of the alternative liquidity measures, indicating that R15 (the cash conversion cycle) and R18 (the net liquid balance) move in accord, with a subtle decrease in the two measures over time. The trend of R16 (the comprehensive liquidity index) indicates a slight increase. According to the theory<sup>15</sup>, these trends in R15, R18 and R16 ostensibly reflect a temporal improvement in the liquidity position of the participating firms. The fitted curve of R24 (the net liquid balance divided by total assets) indicates fluctuations in accord with the economic indicators reflected in figure 5.3.

The arithmetic means over time of the dependent return measures, aggregated over all

15 Working capital theory asserts that a lower cash conversion cycle and net trade cycle indicate greater liquidity, as does a higher comprehensive liquidity index.

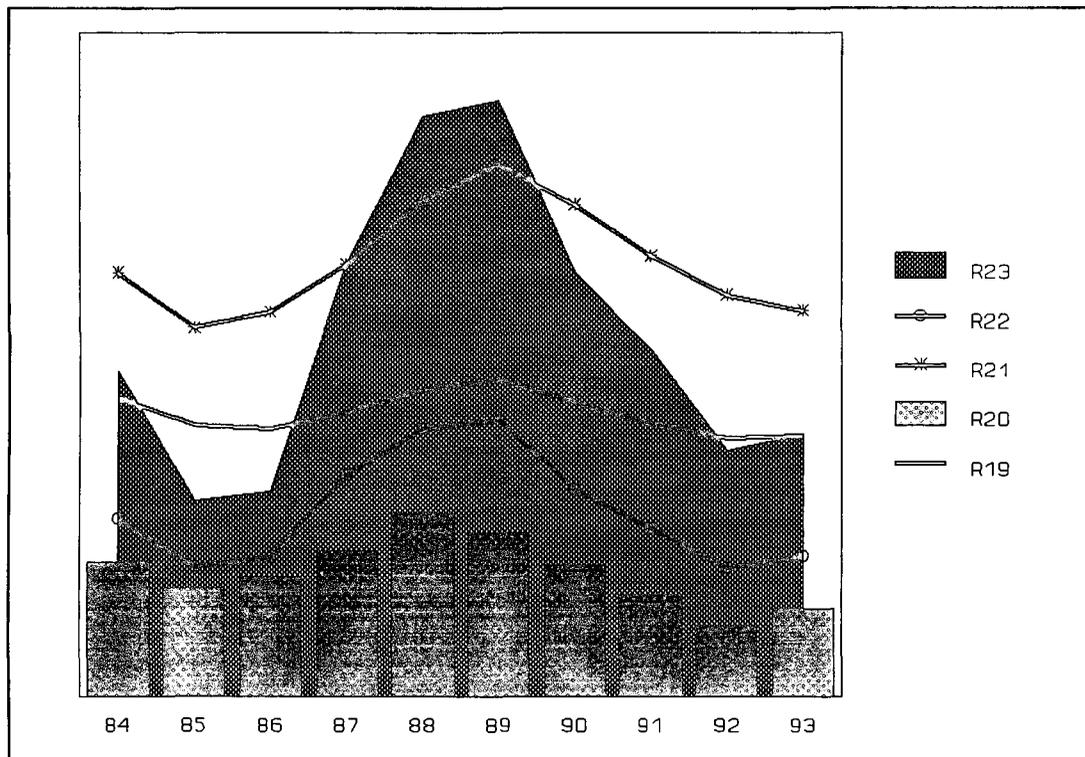
firms, are reflected in table 5.6. All of the return measures display the highest values in the 1988 to 1989 period. The lowest values for R19 (the operating income margin), R20 (the net income margin) and R22 (return on investment) are in 1992, and the lowest values for R21 (operating return on assets) and R23 (return on equity) are measured in 1985.

TABLE 5.6  
ARITHMETIC MEAN OF DEPENDENT MEASURES FOR ALL FIRMS PER YEAR

| YEAR | R19 % | R20 % | R21 % | R22 % | R23 % |
|------|-------|-------|-------|-------|-------|
| 1984 | 13,48 | 6,08  | 19,17 | 8,04  | 14,69 |
| 1985 | 12,25 | 4,90  | 16,69 | 5,89  | 8,82  |
| 1986 | 12,10 | 5,42  | 17,41 | 6,30  | 9,25  |
| 1987 | 12,84 | 6,58  | 19,54 | 10,02 | 19,58 |
| 1988 | 13,86 | 8,25  | 22,47 | 12,11 | 26,20 |
| 1989 | 14,33 | 7,37  | 24,09 | 12,50 | 26,94 |
| 1990 | 13,29 | 5,95  | 22,25 | 9,35  | 19,22 |
| 1991 | 12,34 | 4,63  | 19,94 | 7,62  | 15,71 |
| 1992 | 11,66 | 3,19  | 18,18 | 5,83  | 11,08 |
| 1993 | 11,82 | 3,96  | 17,49 | 6,36  | 11,83 |

In order to visualise the temporal trends in the dependent variables, the values in table 5.6 were plotted over the years, the results of which are reflected in figure 5.6. The observation is that all the dependent measures exhibit similar trends to those embodied in the economic indicators in figure 5.3, thereby displaying plethoric accord with these economic indicators over the years.

FIGURE 5.6  
ARITHMETIC MEAN OF DEPENDENT MEASURES FOR ALL FIRMS PLOTTED OVER  
TIME



In summation, the traditional liquidity measures of R6 (the current ratio) and R11 (the accounts payable turnover) when plotted over time, manifested temporal consistency. R14 (total current liabilities divided by funds flow) on the other hand, displayed a tendency to move in the opposite direction to the economic indicators in figure 5.3. The alternative liquidity measures indicated a slight improvement in the liquidity of the participating firms over time, reflected by a reduction in R15 (the cash conversion cycle) and R18 (the net trade cycle) and an increase in R16 (the comprehensive liquidity index). R24 (net liquid balance divided by total assets) displayed a tendency to move with the economic indicators in figure 5.3, as did all of the return measures (R19 to R23).

The measures, R14, and R19 to R23, all have the income element in common, the dependent variables in the numerator of their formula, and R14 in the denominator<sup>16</sup>. It is therefore not surprising that the dependent measures exhibit temporal fluctuations

16 Sections 4.3.1.3 and 4.4 define the measures in detail.

in the same direction as the economic indicators, and that R14 (total current liabilities divided by funds flow) fluctuates in the opposite direction to the economic indicators. The temporal trends exhibited by R24 (net liquid balance divided by total assets) do not support as apparent cogitation, and the premise might be advanced that the net liquid balance is influenced by the prevailing economic climate.

## 5.6 DECISION TO USE THE MEAN OF 10 YEARS

Data verification tests per year entail time series analysis, which attempts to isolate and quantify the influence of environmental forces on a number of variables (Wegner 1994:329). Scientific time series analysis requires many more than 10 years of observations per firm per variable, the range of which falls outside the scope of this study<sup>17</sup>. Accordingly, including every observation per variable per firm for each year would have meant a violation of the assumptions regarding regression analysis<sup>18</sup>, namely that predicted values in the regression analysis are independent, that is, not sequenced by any variable<sup>19</sup> (Hair 1992:41).

Hence a meaningful proxy for 10 years of observations for each variable for every participating firm had to be decided upon. Among the options were the choice of a particular (subjectively selected) year or years<sup>20</sup> as representative of all 10 years, or the median or some other well-known quantile, or the mean of the variable per firm. The advantage of using the mean as a summary measure (as opposed to a specific year) is that *all* the information contained in the data set is utilised (Wegner 1994:58). After performing ANOVAs on each of the independent variables to ascertain that there were no significant differences amongst the years with respect to the independent variables, it was determined that using the mean over the 10 years was justifiable. Hence the

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17 The justification for using 10 years of variables in this study was previously addressed in section 5.3.

18 Refer to section 6.2.2.1 for the assumptions of regression analysis.

19 In this study the 10 years of data are sequenced, which would be reflected by a consistent pattern of association between residuals and time.

20 Subsequent regressions run for the individual years 1984, 1989 and 1993 did not reveal any trends in the associations between working capital measures and firm returns that might have been aggregated by using the mean, enhancing support for the use of the mean as summary measure for the 10 years of data.

means of 10 years of observations per variable (MR1 to MR25) for each participating firm were used from this point on.

Univariate statistics of the means (MRs) of the dependent and independent variables are presented in table 5.7. Column 2 of the table lists the number of observations per MR variable, and column 3 the scale of measurement. The median values in table 5.7 are smaller than the means for each of the variables, again indicating that the data are positively skewed<sup>21</sup>. Further evidence regarding the non-normal distribution of the data is exhibited in the skewness and kurtosis coefficients of many of the variables. Skewness values falling outside the range of -1 to +1 indicate substantially positively or negatively skewed distributions. A positive kurtosis value indicates a relatively peaked distribution, compared to a normal distribution, while a negative value indicates a relatively flat distribution. The ideal kurtosis value is zero (Hair et al 1992:22, 24).

Table 5.7 shows that the skewness and kurtosis coefficients are particularly extreme for the traditional independent measures, with the most extreme values recorded by variable MR10 (the mean of the accounts receivable turnover) which displays skewness and kurtosis coefficients of 10,60 and 117,12, with values ranging from a minimum of 1,13 and a maximum of 384,31, and a standard deviation of 33,86 appertaining to a mean value of 10,89. Similarly, MR12 (the mean of long-term loan capital divided by net working capital) shows skewness and kurtosis coefficients of 3,76 and 17,37, with values ranging from a minimum of 0,19 and a maximum of 983,46, and a standard deviation of 143,32 appertaining to a mean value of 94,80. Most of the alternative independent measures and all of the dependent measures had less extreme coefficients, with MR19 (the mean of the operating income margin) exhibiting approximately normal skewness and kurtosis coefficients of 0,90 and 1,21, with values ranging from -1,3 to 34,16 and a standard deviation of 6,39 appertaining to a mean value of 12,74.

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21 Also see section 5.4 in this regard.

TABLE 5.7  
 UNIVARIATE STATISTICS FOR THE MEAN PER FIRM (MR) AGGREGATED OVER TIME  
 FOR ALL INDEPENDENT AND DEPENDENT VARIABLES

| MRx  | OBS | SCALE | MEAN   | SD     | MEDIAN | MIN     | MAX    | SKEWNESS | KURTOSIS |
|------|-----|-------|--------|--------|--------|---------|--------|----------|----------|
| MR6  | 135 | %     | 166,27 | 54,65  | 150,76 | 78,7    | 480,42 | 2,01     | 7,68     |
| MR7  | 135 | %     | 98,75  | 43,47  | 87,45  | 20,41   | 288,01 | 1,85     | 4,53     |
| MR9  | 130 | times | 10,58  | 17,32  | 6,72   | 2,62    | 169,35 | 6,92     | 57,26    |
| MR10 | 130 | times | 10,89  | 33,86  | 5,79   | 1,13    | 384,31 | 10,60    | 117,12   |
| MR11 | 130 | times | 7,42   | 2,43   | 7,02   | 3,36    | 17,3   | 1,43     | 3,10     |
| MR12 | 134 | %     | 94,80  | 143,32 | 49,54  | 0,19    | 983,46 | 3,78     | 17,37    |
| MR13 | 135 | %     | 137,81 | 115,23 | 112,61 | 2,71    | 946,96 | 4,58     | 27,21    |
| MR14 | 135 | years | 4,99   | 4,87   | 3,51   | 0,64    | 45,21  | 4,79     | 34,80    |
| MR15 | 130 | days  | 65,79  | 45,94  | 57,10  | -18,34  | 276,61 | 1,42     | 3,95     |
| MR16 | 130 | %     | 137,07 | 41,91  | 130,08 | 31,92   | 385,06 | 2,09     | 10,22    |
| MR18 | 130 | days  | 67,28  | 46,18  | 60,3   | -16,58  | 278,01 | 1,39     | 3,83     |
| MR19 | 130 | %     | 12,74  | 6,39   | 11,97  | -1,3    | 34,16  | 0,90     | 1,21     |
| MR20 | 130 | %     | 5,54   | 6,14   | 4,73   | -17,86  | 31,19  | 1,40     | 6,53     |
| MR21 | 135 | %     | 19,73  | 7,56   | 19,22  | 4,28    | 57,8   | 1,09     | 3,92     |
| MR22 | 135 | %     | 8,43   | 4,88   | 8,39   | -2,07   | 24,37  | 0,38     | 0,59     |
| MR23 | 135 | %     | 16,36  | 10,68  | 16,05  | -11,73  | 70,49  | 1,08     | 5,08     |
| MR24 | 135 | %     | -0,01  | 0,15   | -0,01  | -0,54   | 0,48   | -0,12    | 2,55     |
| MR25 | 130 | %     | 9,49   | 28,74  | 7,88   | -137,66 | 138,74 | -0,83    | 12,19    |

Positive skewness and non-normality are in absolute accord with other research findings on financial ratios, and data transformations are the accepted method of improving the distributional properties of the raw data<sup>22</sup>.

## 5.7 DATA TRANSFORMATION

Data transformation creates new variables from those displaying an undesirable characteristic, such as non-normality, thereby allowing for improved measurement of relationships between variables. The most effective transformation of positively skewed distributions is accomplished by taking logarithms of the variable (Hair et al 1992:52). Logarithmic transformations are widely recognised in the accounting literature as a means of improving the symmetry of positively skewed data (Ezzamel, Mar-Molinero & Beecher: 1987:473).

After exhaustive scrutiny of the influence of a logarithmic transformation on the distribution of each of the 25 variables, it was decided to transform only those variables where the symmetry was markedly improved after transformation. These variables were MR6, MR7, MR9 to MR14, and MR16. Univariate descriptive statistics of the logarithms of the transformed variables are reflected in table 5.8, with the logarithms of the variables represented by LMR6, LMR7, et cetera.

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22 See, eg, Jordaan, et al (1994:70); Muil, Hamman and Smit (1992:21); Ezzamel and Mar-Molinero (1990:7); and Fieldsend, Longford and McLeay (1987:497).

TABLE 5.8  
UNIVARIATE MEASURES OF THE LOG TRANSFORMED MRs

| LWR#  | VARIABLE   | MEAN | SD   | MED  | MIN   | MAX  | SKEW  | KURT  |
|-------|--|------|------|------|-------|------|-------|-------|
| LWR6  | LOG OF THE MEAN OF CURRENT RATIO   | 5.07 | 0.29 | 5.02 | 4.37  | 6.17 | 0.57  | 0.95  |
| LWR7  | LOG OF THE MEAN OF QUICK RATIO   | 4.51 | 0.40 | 4.47 | 3.02  | 5.66 | -0.13 | 2.27  |
| LWR9  | LOG OF THE MEAN OF INVENTORY TURNOVER  | 2.03 | 0.63 | 1.90 | 0.96  | 5.13 | 2.10  | 6.40  |
| LWR10 | LOG OF THE MEAN OF ACCOUNTS RECEIVABLE TURNOVER                                      | 1.91 | 0.67 | 1.76 | 0.12  | 5.95 | 2.28  | 11.01 |
| LWR11 | LOG OF THE MEAN OF ACCOUNTS PAYABLE TURNOVER   | 1.96 | 0.30 | 1.95 | 1.21  | 2.85 | 0.26  | 0.63  |
| LWR12 | LOG OF THE MEAN OF LONG-TERM LOAN CAPITAL / NET CURRENT ASSETS                       | 3.74 | 1.45 | 3.90 | -1.66 | 6.89 | -0.77 | 1.38  |
| LWR13 | LOG OF THE MEAN OF ACCOUNTS RECEIVABLE / ACCOUNTS PAYABLE                            | 4.72 | 0.67 | 4.72 | 1.00  | 6.85 | -1.31 | 8.82  |
| LWR14 | LOG OF THE MEAN OF TOTAL CURRENT LIABILITIES / PROFIT AFTER TAX + NONCASH FLOW ITEMS | 1.34 | 0.69 | 1.25 | -0.44 | 3.81 | 0.40  | 0.55  |
| LWR16 | LOG OF THE MEAN OF COMPREHENSIVE LIQUIDITY INDEX                                     | 4.88 | 0.30 | 4.87 | 3.46  | 5.95 | -0.77 | 5.93  |

TAKING THE LOGARITHMS OF VARIABLES MR15, AND MR18 TO MR25 DID NOT IMPROVE THEIR SYMMETRY, HENCE THESE VARIABLES WERE NOT TRANSFORMED.

Table 5.8 shows that the median values of the logarithmically transformed variables are very close to the means, with the variables reflecting dramatically improved standard deviations in comparison to those in table 5.7. Improved skewness and kurtosis coefficients are evident - for example, skewness and kurtosis coefficients for the logarithm of the mean of accounts receivable turnover (LMR10) are now 2,28 and 11,01 (compared with 10,60 and 117,12 for MR10). Similarly, skewness and kurtosis coefficients of the logarithm of the mean of long-term loan capital divided by net working capital (LMR12) are -0,77 and 1,38 (compared with 3,76 and 17,37 for MR12).

For ratios that are approximately normally distributed, the logarithmic transformation could well exacerbate the approximation to normality (Ezzamel et al 1987:478). Indeed, logarithmic transformations worsened the symmetry of those variables whose MR values were reasonably symmetric - that is, all of the alternative independent variables except for MR16 (the mean of the comprehensive liquidity index) and all of the dependent variables. In the case of MR25 (the mean of turnover divided by net working capital) the logarithmic transformation worsened the skewness and kurtosis coefficients from -0,83 and 12,19 for MR25 to -8,88 and 89,76 for LMR25 (the logarithm of the mean of turnover divided by net working capital). Thus for obvious reasons, these variables were not transformed.

The histograms, stem-and-leaf plots and boxplots in figure 5.7 display the distributional patterns in typical log transformed data, while normal probability plots confirm the success of the transformation in obtaining normality. They indicate consistently improved distributions for the variables<sup>23</sup>, showing considerably enhanced symmetry in the plots in comparison to the plots of the raw data. The presence of symmetry in the transformed variables justified the use of the logarithms of variables MR6 to MR14, and MR16 for further statistical tests.

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23 The choice of LMR6, LMR10, LMR14 and LMR16 for inclusion in figure 5.7 was again an arbitrary one.

FIGURE 5.7 (a)  
STEM-AND LEAF, BOXPLOT AND NORMAL PROBABILITY PLOT FOR LMR6 (THE LOG OF THE MEAN OF THE CURRENT RATIO)

Variable=LMR6

LOG Current Ratio (%)

| Stem Leaf                   | #  | Boxplot |
|-----------------------------|----|---------|
| 61 7                        | 1  | 0       |
| 60                          |    |         |
| 59                          |    |         |
| 58                          |    |         |
| 57 68                       | 2  |         |
| 56 027                      | 3  |         |
| 55 22499                    | 5  |         |
| 54 022457                   | 6  |         |
| 53 011444456678             | 12 |         |
| 52 000113666899             | 12 | +-----+ |
| 51 123456666777799          | 15 |         |
| 50 0011222455678999         | 16 | *-----* |
| 49 001133334455556778888899 | 24 |         |
| 48 011355566666778889       | 18 | +-----+ |
| 47 01346688889              | 11 |         |
| 46 146999                   | 6  |         |
| 45 57                       | 2  |         |
| 44                          |    |         |
| 43 79                       | 2  |         |

-----+-----  
Multiply Stem.Leaf by 10\*\* -1

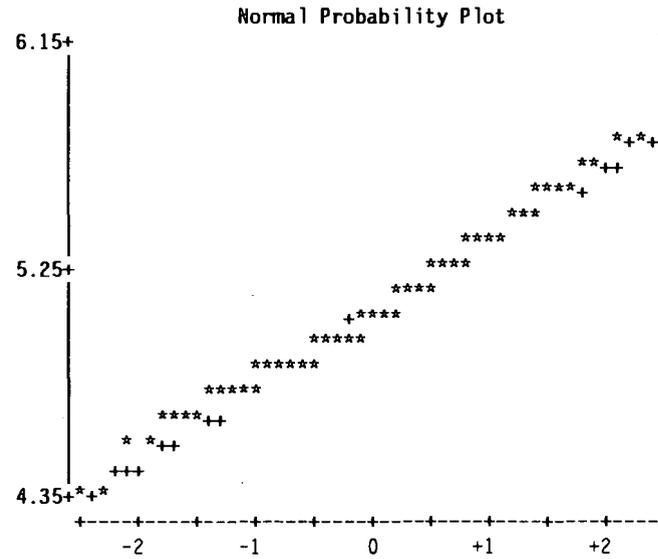


FIGURE 5.7 (b)  
 HISTOGRAM, BOXPLOT AND NORMAL PROBABILITY PLOT FOR LMR10 (THE LOG OF THE MEAN OF ACCOUNTS RECEIVABLE TURNOVER)

Variable=LMR10

LOG Turnover/accounts receivable (times)

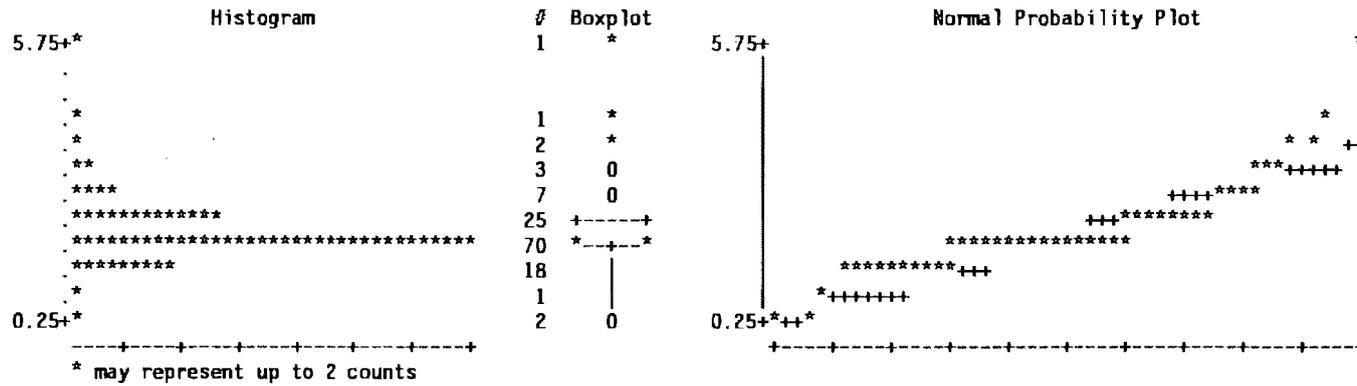


FIGURE 5.7 (c)  
STEM-AND LEAF, BOXPLOT AND NORMAL PROBABILITY PLOT FOR LMR14 (THE LOG OF THE MEAN OF TOTAL CURRENT LIABILITIES DIVIDED BY FUNDS FLOW)

Variable=LMR14

LOG Total current liabilities divided by gross funds flow (days)

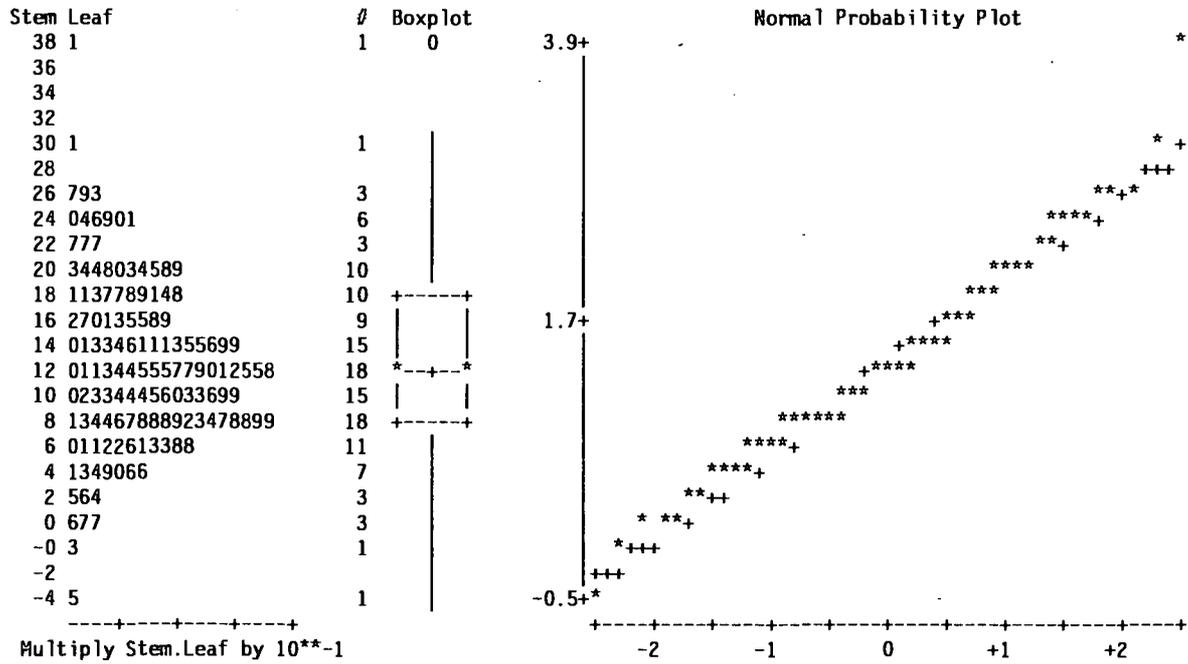
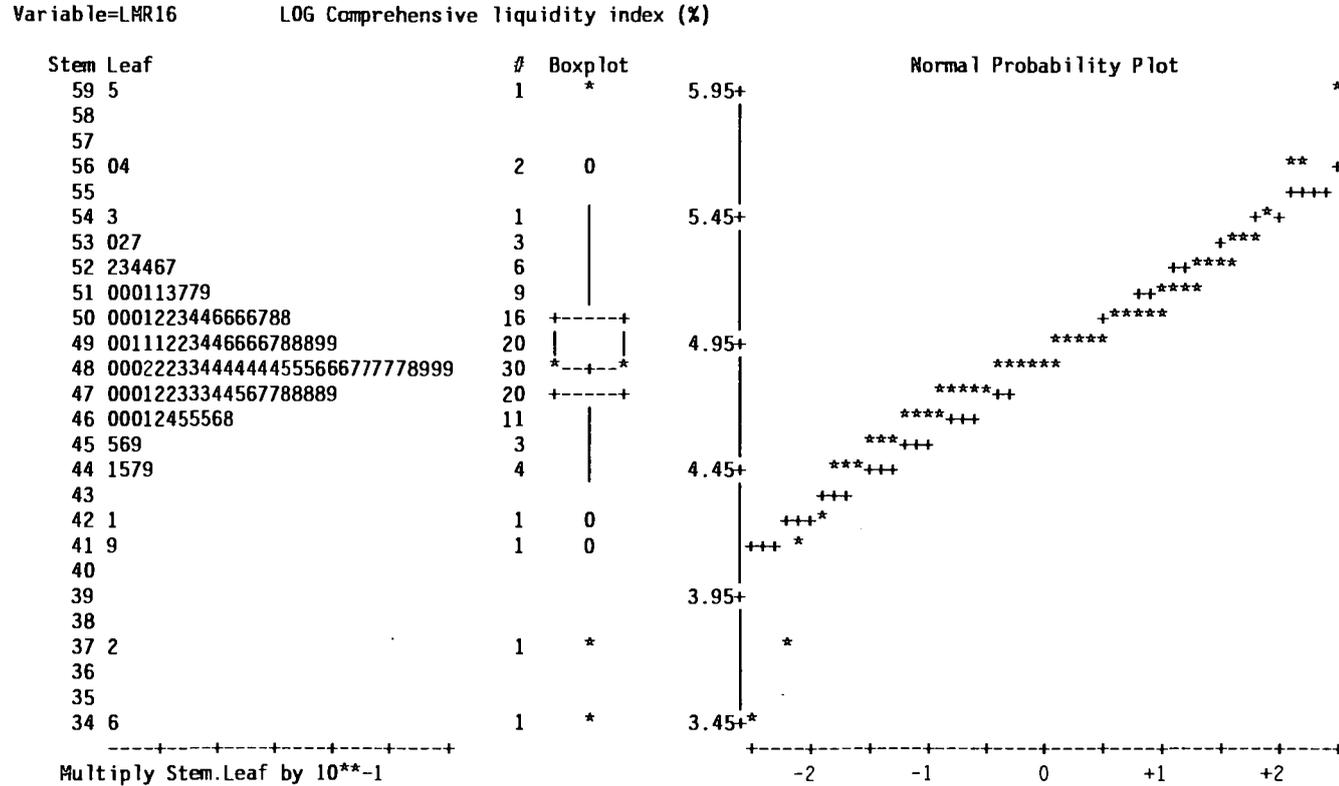


FIGURE 5.7 (d)  
 STEM-AND LEAF, BOXPLOT AND NORMAL PROBABILITY PLOT FOR LMR16 (THE LOG OF THE MEAN OF THE COMPREHENSIVE LIQUIDITY INDEX)



At this point a positive comment should be made on non-normal data. Multivariate normal central limit theory gives convergence in distribution to the normal law for the sum of an increasing number of random variables (Kotz & Johnson 1986:651). This means that even when data are appropriated from a population whose frequency distribution is not normal, the distribution of the mean of the data sets will tend to assume approximate normality as the size of the data sets becomes large (Hutchinson 1993:29; Lapin 1990:253). In this regard, many statistical distribution tables, for example, Sekaran (1992:407-413), consider population samples of more than 120 as infinite, reflected by the symbol  $\infty$ .

The use of symmetrically improved log-transformed data (where appropriate), combined with the magnitude of the data set<sup>24</sup>, meant that further statistical procedures, encompassing parametric tests, and their assumptions regarding the symmetry of the distribution of the data set, could be performed with confidence. Added justification for this reasoning is that the statistical techniques envisaged in further testing are by nature robust to deviations from the assumptions on which they are based<sup>25</sup>, provided the data are symmetric.

## 5.8 SUMMARY

The purpose of this chapter was to describe the exploratory data analysis undertaken in the empirical research of the association between traditional and alternative working capital measures and firm returns. To this end, financial statement data on South African industrial firms listed on the JSE for the period 1984 to 1993 were obtained from the University of Pretoria's Bureau of Financial Analysis.

After elimination of pyramid and foreign firms, a database of 135 firms remained, for which 25 variables for each year were extracted. Included in these variables were nine traditional and four alternative liquidity measures, constituting the independent variables, and five measures of return, constituting the dependent variables.

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24 There are at least 130 observations per MR variable, as reflected in the second column of table 5.7.

25 See Ezzamel and Mar-Molinero (1990:27); and Chan and Lakonishok (1992:266).

The Statistical Analysis System calculated univariate statistics, and generated a total of 675 histograms for exploratory scrutiny of the database. The histograms showed that the data were prevalently positively skewed, and tests for normality were rejected at the five percent level of significance for all variables aggregated over time and sector.

Descriptive statistics disclosed that current assets for all participating firms represented, on average, 60 percent of total assets, and current liabilities, on average, 81 percent of total liabilities. Temporal tendencies in the independent and dependent variables showed that R6 (the current ratio) and R7 (the quick ratio) were consistent over the 10 years. R14 (total current liabilities divided by funds flow) fluctuated in opposite trends to the economic indicators. In contrast, R24 (the net liquid balance divided by total assets) and all of the return measures, representing the dependent variables of R19 to R23, moved in accordance with the economic indicators. The alternative liquidity measures of R15 (cash conversion cycle), R16 (comprehensive liquidity index) and R18 (net trade cycle), manifested a slightly improving trend in liquidity in the participating firms over time.

The mean per firm (MR) of each variable for the 10 years of data was chosen as the most representative measure for the study. Examination of the distributional properties of the means revealed that most variables displayed positive skewness and high kurtosis. The recognised method in the literature of improving the distributional properties of positively skewed non-normal raw data is by means of logarithmic transformations.

Univariate measures of the logarithms of the transformed variables indicated consistently improved symmetry in the case of all of the traditional variables (except MR25, the mean of turnover divided by net working capital), and one alternative variable, MR16, (the mean of the comprehensive liquidity index), justifying the use of log transformations for these variables in further data analysis. The presence of symmetry in the transformed variables, combined with the magnitude of the data set, meant that the data confirmation step could be pursued with conviction.

The paradigm of the association between the traditional and alternative working capital measures of liquidity and returns will be investigated in depth in the confirmatory statistical tests to follow. These tests, described in the next chapter, are chi-square tests

for association, stepwise regression of independent with dependent variables, t-tests for size effect and nonparametric tests for sector effect.

## CHAPTER 6

## ANALYSIS OF RESULTS

## 6.1 INTRODUCTION

In the previous chapter, the exploratory data analysis step was undertaken in the investigation of the association between traditional and alternative working capital measures of liquidity and recognised measures of return. This chapter focuses on the data confirmation step in this investigation.

As expounded in the introduction to the data analysis in section 5.1, data confirmation involves the use of multivariate techniques to investigate predefined relationships. The approach followed in the data confirmation step is to address each of the three research hypotheses<sup>1</sup> according to the statistical tests applied to prove or disprove the hypotheses. The Statistical Analysis System (SAS) was used to perform the tests.

The first hypothesis was initially substantiated with a chi-square test for association. Thereafter stepwise multiple regression analysis was applied in order to build a model to describe the association between each dependent and the independent variables. With reference to the second hypothesis, t-tests were applied in order to verify the influence of size on the working capital measures employed by industrial firms. The third hypothesis required the use of a nonparametric test - in this case the Kruskal-Wallis test was applied, to examine the sectoral influence on the working capital measures employed by industrial firms.

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1 These are defined in section 1.5.

## 6.2 STATISTICAL TESTING OF HYPOTHESIS 1

Hypothesis 1 states that traditional and alternative working capital measures associate differently with the returns of South African listed industrial firms. In order to statistically substantiate the hypothesis, a chi-square test for association was initially performed. Thereafter, a stepwise regression analysis was performed, in an effort to quantify the underlying relationships between the working capital measures (independent variables) and firm returns (dependent variables).

### 6.2.1 Chi-square test

The objective of the chi-square test is to statistically establish significant associations between the dependent and independent variables. The common feature of all applications of the chi-square test is the availability of a sufficient sample size<sup>2</sup>. If the sample size is too small, too many cells will have small frequencies<sup>3</sup>. Hence the sample size needs to be big enough to prevent zero expected cell frequencies.

The chi-square application used in this study is the Pearson chi-square statistic which tests for independence of association for two-dimensional contingency tables. The SAS PROC FREQ command was used to compute the statistics for the two-way tables that test the statistical null hypothesis of no association. The medians<sup>4</sup> of all independent<sup>5</sup> and dependent<sup>6</sup> variables were calculated. All observations per variable were then classified into below and above the variable median. The test is essentially to see whether the observed frequencies, the variables above and below the median, differ significantly from the expected frequencies<sup>7</sup>, in which case, association is established.

The statistical null hypothesis reads  $H_0$  : observed values = expected values, that is, no

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2 The size issue was addressed in section 5.7.

3 By this is meant frequencies of less than five.

4 The median was used to ensure the minimisation of the influence of extreme values in the data set (Soenen 1993:56).

5 LMR6, LMR7, LMR9 to LMR14, MR15, LMR16, MR18, MR24 and MR25.

6 MR19 to MR23.

7 We would expect around 50 percent of the values above and 50 percent below the median.

association. The degrees of freedom for the test are (number of rows in the two-way table - 1) times (number of columns in the two-way table - 1), that is  $(2 - 1)(2 - 1) = 1$ . At the five percent level of significance, the critical value for the chi-square ( $\chi^2$ ) statistic is 3,84 (Lapin 1990:961). If  $\chi^2 \leq 3,84$ , accept  $H_0$ . If  $\chi^2 > 3,84$  reject  $H_0$ . The rejection of  $H_0$  would indicate that there is association between the independent and dependent variables.

Tables 6.1 and 6.2 are synopses of the chi-square and exceedence probabilities (ie p-values) reflected by the two-way tables of the independent variables versus the dependent variables.  $H_0$  can be rejected, at the five percent level of significance, in those instances that are shaded in tables 6.1 and 6.2, with negative associations depicted in brackets.

The  $\chi^2$ -values in table 6.1 can be interpreted as follows: at the five percent level of significance, MR19 (the mean of the operating income margin) displays significant positive association with LMR6 (the log of the mean of the current ratio), LMR7 (the log of the mean of the quick ratio) and LMR13 (the log of the mean of accounts receivable divided by accounts payable). MR19 further displays significant negative association with LMR10 (the log of the mean of the accounts receivable turnover), LMR14 (the log of the mean of total current liabilities divided by funds flow) and MR25 (the mean of turnover divided by net working capital).

MR20 (the mean of the net income margin) indicates significant negative association exclusively with LMR14 (the log of the mean of total current liabilities divided by funds flow) and MR25 (the mean of turnover divided by net working capital). In similar fashion,  $\chi^2$  values for MR21 (the mean of the operating return on assets) show significant positive association with LMR6 (the log of the mean of the current ratio), LMR10 (the log of the mean of the accounts receivable turnover) and LMR11 (the log of the mean of the accounts payable turnover); and significant negative association with LMR12 (the log of the mean of long-term loan capital divided by net working capital) and LMR14 (the log of the mean of total current liabilities divided by funds flow), and so forth.

TABLE 6.1  
CHI-SQUARE AND PROBABILITY STATISTICS FOR ASSOCIATION BETWEEN THE  
DEPENDENT VARIABLES<sup>8</sup> AND THE TRADITIONAL INDEPENDENT VARIABLES<sup>9</sup>

| DEPENDENTS | MR19     |      | MR20     |      | MR21     |      | MR22     |      | MR23     |      |
|------------|----------|------|----------|------|----------|------|----------|------|----------|------|
|            | $\chi^2$ | Prob |
| LMR 6      | 6,95     | 0,01 | 3,73     | 0,05 | 3,91     | 0,05 | 0,89     | 0,35 | 0,61     | 0,44 |
| LMR 7      | 6,92     | 0,01 | 3,72     | 0,05 | 0,60     | 0,44 | 3,27     | 0,07 | 0,19     | 0,67 |
| LMR 9      | (3,72)   | 0,05 | 0,03     | 0,86 | 1,51     | 0,22 | 4,43     | 0,04 | 0,28     | 0,60 |
| LMR10      | (9,97)   | 0,00 | 0,12     | 0,73 | 4,43     | 0,04 | 8,91     | 0,00 | 4,43     | 0,04 |
| LMR11      | 0,03     | 0,86 | 1,51     | 0,22 | 6,92     | 0,01 | 6,03     | 0,01 | 0,28     | 0,60 |
| LMR12      | 1,76     | 0,19 | 2,81     | 0,09 | (5,04)   | 0,03 | (6,71)   | 0,01 | 2,41     | 0,12 |
| LMR13      | 5,21     | 0,02 | 1,51     | 0,22 | 0,19     | 0,67 | 0,90     | 0,34 | (3,92)   | 0,05 |
| LMR14      | (25,30)  | 0,00 | (56,89)  | 0,00 | (24,05)  | 0,00 | (35,26)  | 0,00 | (8,05)   | 0,01 |
| MR25       | (13,57)  | 0,00 | (6,92)   | 0,01 | 0,77     | 0,38 | 0,12     | 0,73 | 0,77     | 0,38 |

The highest  $\chi^2$  statistics, signifying the greatest associations, were between LMR14 (the log of the mean of total current liabilities divided by funds flow) and the return measures, with negative association in all cases - that is, low LMR14 and high dependent variable, and vice versa. This is not surprising, considering the common income element present in the denominator of total current liabilities divided by funds flow (R14) and in the numerator of the dependent variables<sup>10</sup>. The negative association also corresponds with normative theory which states that a smaller total current liabilities divided by funds flow

- 8 The dependent variables are:  
 MR19 = the mean of the operating income margin  
 MR20 = the mean of the net income margin  
 MR21 = the mean of the operating return on assets  
 MR22 = the mean of return on investment  
 MR23 = the mean of return on equity

- 9 The traditional independent variables are:  
 LMR6 = the log of the mean of the current ratio  
 LMR7 = the log of the mean of the quick ratio  
 LMR9 = the log of the mean of inventory turnover  
 LMR10 = the log of the mean of accounts receivable turnover  
 LMR11 = the log of the mean of accounts payable turnover  
 LMR12 = the log of the mean of long-term loan capital divided by net working capital  
 LMR13 = the log of the mean of accounts receivable divided by accounts payable  
 LMR14 = the log of the mean of total current liabilities divided by funds flow  
 MR25 = the mean of turnover divided by net working capital

- 10 See section 6.2.2.6 for further discussion on this.

is preferable to a larger one<sup>11</sup>, which should be beneficial for firm returns.

The  $\chi^2$  statistics for LMR6 ( the log of the mean of the current ratio) and LMR7 (the log of the mean of the quick ratio), in contrast, indicated positive association with the dependent variables. A high LMR6 and LMR7 were mostly accompanied by a high return measure, and vice versa. This positive association does not correspond with theory, which states that liquidity and returns should be negatively associated, or that higher liquidity is related to higher costs for the firm, and therefore lower returns. Nevertheless, these findings are in agreement with those of other research, namely Kamath (1989:28), who found that the current and quick ratios did not exhibit the expected inverse relationship with an operating profit measure. Also of note is the negative association of MR25 (the mean of turnover divided by net working capital) with MR19 (the mean of the operating income margin) and MR20 (the mean of the net income margin). Here, normative speculation would be for positive association, since a higher turnover divided by net working capital (R25) is preferable.

LMR10 (the log of the mean of the accounts receivable turnover) and LMR11 (the log of the mean of the accounts payable turnover) displayed significant positive association with MR21 (the mean of the operating return on assets) and MR22 (the mean of return on investment). Finance theory advocates a higher accounts receivable turnover (R10), and a lower accounts payable turnover (R11), implying that the positive association for LMR10 agrees with the theory, but one would expect LMR11 to display negative association with returns. LMR12 (the log of the mean of long-term loan capital divided by net working capital) demonstrates significant negative association with MR21 (the mean of the operating return on assets) and MR22 (the mean of return on investment). This is in agreement with the concept that a lower ratio of long-term loan capital to net working capital should be accompanied by higher returns.

The positive association between LMR10 (the log of the mean of the accounts receivable turnover) and MR23 (the mean of return on equity) and the negative association between LMR13 (the log of the mean of accounts receivable divided by accounts payable) and

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11 This was discussed in the theory chapter on working capital measures, in particular, section 4.3.1.3.

MR23 are also according to conjecture, with a higher accounts receivable turnover (R10) and a lower accounts receivable divided by accounts payable (R13) being preferable.

TABLE 6.2  
CHI-SQUARE AND PROBABILITY STATISTICS FOR ASSOCIATION BETWEEN THE  
DEPENDENT VARIABLES<sup>12</sup> AND ALTERNATIVE INDEPENDENT VARIABLES<sup>13</sup>

| DEPENDENTS | MR19     |      | MR20     |      | MR21     |      | MR22     |      | MR23     |      |
|------------|----------|------|----------|------|----------|------|----------|------|----------|------|
|            | $\chi^2$ | Prob |
| MR15       | 8.89     | 0.00 | 2.49     | 0.11 | 0.28     | 0.60 | 1.97     | 0.16 | (5.20)   | 0.02 |
| LMR16      | 1.51     | 0.22 | 0.28     | 0.60 | 1.51     | 0.22 | 3.10     | 0.08 | 0.28     | 0.60 |
| MR18       | 6.92     | 0.01 | 1.51     | 0.22 | 0.03     | 0.86 | 1.11     | 0.29 | 2.49     | 0.11 |
| MR24       | 0.28     | 0.60 | 5.21     | 0.02 | 1.25     | 0.26 | 12.45    | 0.00 | 2.13     | 0.14 |

The  $\chi^2$  values in table 6.2 exhibit few significant values, with MR15 (the mean of the cash conversion cycle) and MR18 (the mean of the net trade cycle) displaying positive association with MR19 (the mean of the operating income margin). MR24 (the mean of the net liquid balance divided by total assets) arrays positive association with MR20 (the mean of the net income margin) and MR22 (the mean of return on investment). MR15 (the mean of the cash conversion cycle) exhibits significant negative association with MR23 (the mean of return on equity).

It is also evident from table 6.2 that LMR16 (the log of the mean of the comprehensive liquidity index) displays no significant association with any of the dependent variables. Correspondingly, MR21 (the mean of the operating return on assets) has no significant association with any of the alternative independent variables<sup>14</sup>.

The positive association recorded between the means of the cash conversion cycle (MR15) and the net trade cycle (MR18), and the dependent variables, deviates from the

12 See previous footnote 8 in this chapter for a listing of the dependent variables.

13 The alternative independent variables are:

MR15 = the mean of the cash conversion cycle

LMR16 = the log of the mean of the comprehensive liquidity index

MR18 = the mean of the net trade cycle

MR24 = the mean of the net liquid balance divided by total assets.

14 The results of regression tests using only alternative measures (see sec 6.2.2.3) reinforced this finding.

theory, which states that a low cash conversion cycle, and low net trade cycle should be accompanied by higher returns (of course this is not the case with the negative association between MR15 and MR23 [the mean of return on equity]). The positive association between MR24 (the mean of the net liquid balance divided by total assets) and MR20 (the mean of the net income margin), in contrast, is in agreement with normative conjecture - that is, a higher net liquid balance as a percentage of total assets (R24) should be accompanied by greater returns.

The frequencies above and below the median in the two-way tables provide evidence of significant positive and negative association between the independent traditional and alternate working capital measures and the return measures. In the main, the chi-square statistics indicate more frequent occurrences of significant association between traditional liquidity measures and returns than between alternative liquidity measures and returns. However, these associations do not prove a cause-effect relationship, but rather how variables vary in relation to each other (Underhill & Bradfield 1994:279). Augmented insight regarding these associations between the independent and dependent measures requires further statistical procedures. The paradigm of these associations, and more specifically, the quantification of the underlying structural relationship between the dependent and independent variables (Wegner 1994:302), is the purpose of the regression tests to follow.

### 6.2.2 Regression analysis

Multiple regression analysis is an appropriate technique to employ when the research involves a single metric dependent variable presumed to be related to one or more metric independent variables (Hair et al 1992:7). Hence the object of (multiple) regression analysis is to account for the anomalies in the dependent variables, where the values of each dependent variable are described and explained in terms of one or more of the independent variables (SAS/stat user's guide 1990a:898). Multiple regression analysis was used in this study to assess and quantify the underlying structural relationship between each return measure (dependent variable) and the traditional and alternative working capital measures (independent variables).

The SAS PROC REG with SELECTION = STEPWISE procedure was used to perform stepwise forward regression. By this method each independent variable, starting with the one most highly correlated with the dependent variable, is considered for inclusion prior to developing the regression equation. In the next and each subsequent step, the partial correlation coefficients are examined each time a new variable is entered, to ascertain whether the additional variable explains a significant portion of the error remaining. The regression equation is then recalculated using the two independent variables, and the partial F value for the original variable in the model examined to see whether it still makes a significant contribution, given the presence of the new independent variable (Hair et al 1992:57). In this way, the procedure is continued until all independent variables have been examined for inclusion in the model, whilst at each step those already included are reassessed to consider whether they should remain (if not, these variables are excluded from the regression equation again). The process is terminated when no more variables are deemed significant enough to enter the model.

The normal composition of a regression model with multiple independent variables is

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_kX_k$$

where Y = dependent variable (MR19 to MR23)

a = intercept or constant

$b_i$  = regression coefficient for independent variable  $X_i$ ;  $i = 1, 2, \dots, k$

$X_i$  = independent variable,  $i = 1, 2, \dots, k$

The  $R^2$  (multiple coefficient of determination) values are interpreted as the percentage variance in the dependent variable explained jointly by all of the independent variables in the regression model. The emphasis in this research was on determining associations, hence the independent variables in the regression models were used for explanatory and not predictive purposes (Marx 1992:152).

A regression model for each of the dependent variables is now considered.

### 6.2.2.1 Regression model for the operating income margin

The full regression model for MR19 (the mean of the operating income margin) forcing all independent variables into the regression equation, yields an  $R^2$  of 0,6061. This means that the maximum variance of MR19 that can be explained by the independent variables is 60,61 percent.

A stepwise regression was subsequently performed to obtain an appropriate model for MR19. Table 6.3 presents the results of these regression steps.

TABLE 6.3  
THE RESULTS OF STEPWISE REGRESSION OF THE INDEPENDENT VARIABLES WITH  
MR19 (THE MEAN OF THE OPERATING INCOME MARGIN)

| Step | Variable entered   | Final model $R^2$ | Standardised regression coefficient |
|------|--|-------------------|-------------------------------------|
| 1    | LMR14 (the log of the mean of total current liabilities divided by funds flow)       | 0,4475            | -0,80                               |
| 2    | LMR10 (the log of the mean of accounts receivable turnover)                          | 0,5268            | -                                   |
| 3    | LMR11 (the log of the mean of accounts payable turnover)                             | 0,5443            | -0,26                               |
| 4    | MR18 (the mean of the net trade cycle)   | 0,5588            | 0,29                                |
| 5    | (LMR10 (the log of the mean of accounts receivable turnover)                         | 0,5550            | -                                   |
| 6    | LMR12 (the log of the mean of long-term loan capital divided by net working capital) | 0,5739            | 0,14                                |
| 7    | MR15 (the mean of the cash conversion cycle)   | 0,5824            | -                                   |
| 8    | LMR6 (the log of the mean of the current ratio)                                      | 0,5919            | -                                   |

The 8-step regression model for MR19 resulted in an  $R^2$  of 0,5919, indicating that a total of 59,19 percent of the variance in MR19 can be explained by the independent variables in this model. By far the greatest contribution comes from LMR14 (the log of the mean of total current liabilities divided by funds flow), namely 44,75 percent. LMR10 (the log

of the mean of the accounts receivable turnover) was entered into the equation in step 2, but removed again in step 5, after the admission of MR18 (the mean of the net trade cycle). This is probably due to multicollinearity between LMR10 and some of the other variables already in the equation.

Because of the insignificant improvement in the percentage variance explained from step 7 (less than one percent per variable added), it was decided to limit the estimated regression equation to the first six steps. The estimated 6-step regression equation for MR19 is:

$$MR19_e = 28,40 - 7,39LMR14 - 5,53LMR11 + 0,04MR18 + 0,62LMR12$$

This means that the 6-step regression model, with an  $R^2 = 0,5739$ , explains  $0,5739 / 0,6061 = 95$  percent of all variance in MR19 that can possibly be explained by the independent variables included in the study.

The interpretation of the estimated regression equation for MR19 (the mean of the operating income margin) is that some of the independent variables have a positive influence on the dependent variable within the regression framework (MR18 and LMR12), while others have negative influences (LMR14 and LMR11). An increase in MR18 and LMR12 will therefore increase MR19, while an increase in LMR14 and LMR11 will decrease MR19. The amount of the increase or decrease would differ for each variable on the basis of the regression coefficient. The regression coefficients in the model indicate the partial influence exerted on the dependent variable by a particular independent variable if the other independent variables are kept constant (Marx 1992:179).

- \* A unit increase in LMR14 (the log of the mean of total current liabilities divided by funds flow [measured in years]), would produce an expected 7,39 percent decrease in MR19.
- \* A unit increase in LMR11 (the log of the mean of the accounts payable turnover

[measured in times]) would produce an expected 5,53 percent decrease in MR19<sup>15</sup>.

- \* A unit increase in MR18 (the mean of the net trade cycle [measured in days]) would produce an expected 0,04 percent increase in MR19.
- \* A unit increase (one percent) in LMR12 (the log of the mean of long-term loan capital divided by net working capital) would produce an expected 0,62 percent increase in MR19.

It is not appropriate to interpret the regression coefficients as indicators of the relative importance of the variables, as the true amplitude of the coefficients hinges on the units in which the variables are measured. So where the units of measurement of the variables differ substantially, the absolute magnitude of their coefficients does not divulge anything about their relative importance. A method of ameliorating the comparability of regression coefficients within a regression equation is to standardise them. This may be done by multiplying each regression coefficient by the ratio of the standard deviation of the independent variable to the standard deviation of the dependent variable to obtain Beta ( $\beta$ ), the unit-free standardised regression coefficient (Norusis 1993:314, 342). Hence the standardised regression coefficients given in table 6.3 for the variables in the regression model for MR19, indicate that LMR14 (the log of the mean of total current liabilities divided by funds flow) with a  $\beta$  of -0,80, explains relatively nearly three times more of the variation in MR19 than LMR11 and MR18, with  $\beta$ 's of -0,26 and 0,29 respectively, and nearly six times more than LMR12, with a  $\beta$  of 0,14<sup>16</sup>.

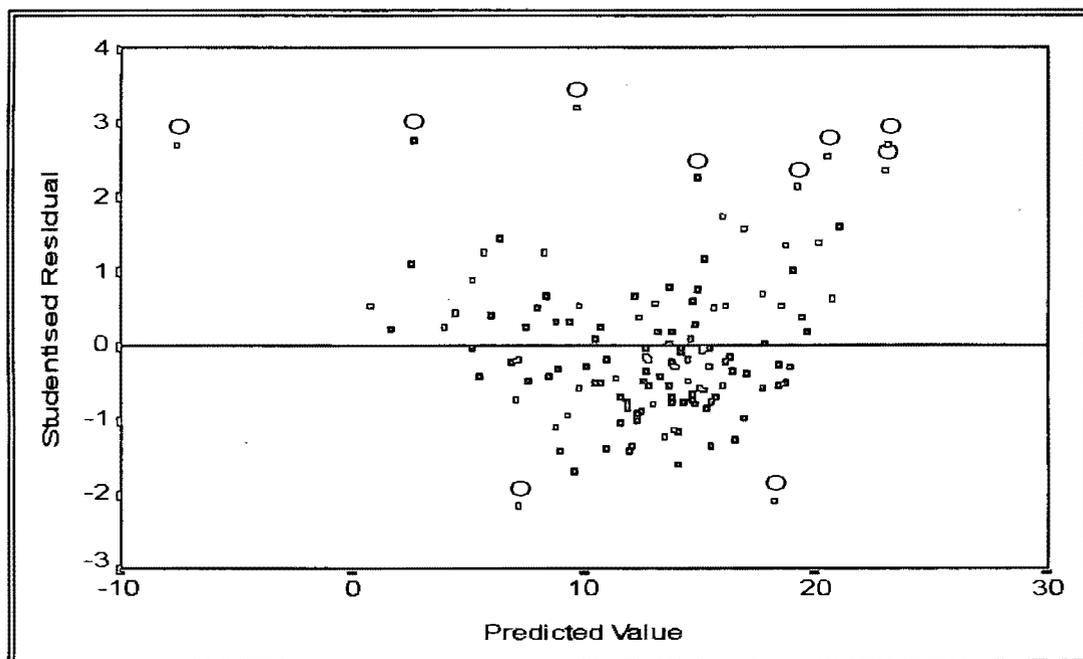
The appropriateness of the regression model was assessed by a graphical analysis. Plots of the studentised residuals versus the predicted variables is the most common method of identifying assumption variations<sup>17</sup>. The assumptions to be examined are:

- 
- 15 With logarithms, the interpretation of the regression coefficients depends entirely on the specific mean value of the independent variable. This is because the logarithmic curve does not have a constant slope (as in a straight line). Each unit change in the mean value would thus produce a different effect on the dependent variable, depending on where (on the graph) the unit change takes place.
  - 16 It should be borne in mind that the  $\beta$  coefficients are interpreted relative to the other variables in the regression equation.
  - 17 To this end, see Everitt and Dunn (1991:156-166); and Hair et al (1992:69-76).

1. linearity of the phenomenon measured
2. constancy of the variance of the error terms (residuals)
3. independence of the error terms
4. normality of the error term distribution (Hair 1992:38).

Figure 6.1 represents a plot of the predicted values of MR19 against the studentised residuals.

FIGURE 6.1  
PLOT OF PREDICTED VALUES VERSUS STUDENTISED RESIDUALS FOR MR19 (THE  
MEAN OF THE OPERATING INCOME MARGIN)



The residual plot of the regression model for MR19 exhibits a random scattering around the zero residual value with no nonlinear pattern or definite pattern of decreasing or increasing residuals discernible. This demonstrates independence and constancy in the variance (homoscedasticity) of the residuals over the range of the independent variables (Hair et al 1992:71). A number of points<sup>18</sup> is discernible in the plot, lying beyond the five

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18 These are the values marked with an O in figure 6.1.

percent significance values of -1,96 and 1,96<sup>19</sup>. As the outliers in the data set were regarded as representative of the data, and therefore retained<sup>20</sup>, it is not unexpected that there are deviations of this magnitude between some of the observed and estimated values. The examination of the residual plots accordingly inferred the verification of the aptness of the 6-step model for MR19 regarding the regression assumptions.

Further stepwise regression analysis was performed using only the traditional measures (LMR6, LMR7, LMR9-LMR14, MR25). A 4-step regression model produced an  $R^2$  of 0,5537 for the traditional measures with LMR14 (the log of the mean of total current liabilities divided by funds flow) as expected, displaying the same partial  $R^2$  of 0,4475. Using only alternative measures, a 2-step regression model produced an  $R^2$  of 0,0975 with MR18 (the mean of the net trade cycle) contributing 0,0318 in the first step, and MR24 (the mean of the net liquid balance divided by total assets) contributing 0,0657 in the second step.

#### 6.2.2.2 Regression model for the net income margin

The full regression model for MR20 (the mean of the net income margin) yields an  $R^2$  of 0,5395. This means that the maximum variance of MR20 that can be explained when all of the independent variables are forced into the regression model is 53,95 percent. The results of the stepwise regression are presented in table 6.4 .

TABLE 6.4  
THE RESULTS OF STEPWISE REGRESSION OF THE INDEPENDENT VARIABLES WITH  
MR20 (THE MEAN OF THE NET INCOME MARGIN )

| Step | Variable entered   | Final model $R^2$ | Standardised regression coefficient |
|------|--|-------------------|-------------------------------------|
| 1    | LMR14 (the log of the mean of total current liabilities divided by funds flow) | 0,4225            | -0,58                               |
| 2    | MR24 (the mean of the net liquid balance divided by total assets)              | 0,4490            | 0,18                                |

19 The -1,96 and 1,96 values may be approximated to a values of -2 and 2 for simplicity.

20 This is in line with the decision taken on outliers during data exploration. See section 5.4 in this regard.

The 2-step regression model for MR20 resulted in an  $R^2$  of 0,4490, indicating that 44,90 percent of the variance in MR20 can be explained by the independent variables in this model. Again, the greatest contribution (42,25%), came from LMR14 (the log of the mean of total current liabilities divided by funds flow). The estimated regression equation for MR20 is:

$$MR20_e = 12,48 - 5,15LMR14 + 7,67MR24$$

Thus the 2-step regression model, with an  $R^2 = 0,4490$ , explains  $0,4490 / 0,5395 = 83$  percent of all variance in MR20 that can possibly be explained by the independent variables included in the study.

The interpretation of the estimated regression equation for MR20, the mean of the net income margin, is as follows:

- \* A unit increase in LMR14 (the log of the mean of total current liabilities divided by funds flow [measured in years]), would produce an expected 5,15 percent decrease in MR20.
- \* A one percent increase in MR24 (the mean of the net liquid balance divided by total assets) would produce an expected 7,67 percent increase in MR20.

In conceding the inappropriateness of interpreting the regression coefficients as indicators of the relative importance of the variables, the standardised regression coefficients given in table 6.4 for the variables in the regression model for MR20 are examined. These indicate that LMR14 (the log of the mean of total current liabilities divided by funds flow), with a  $\beta$  of -0,58, explains just over three times more of the variation in MR20 than MR24 with a  $\beta$  of 0,18.

The appropriateness of the regression model for MR20 was assessed by means of a graphical analysis, that is, examination of the residuals. Figure 6.2 is a plot of the predicted values of MR20 against the studentised residuals.

FIGURE 6.2  
 PLOT OF PREDICTED VALUES VERSUS STUDENTISED RESIDUALS FOR MR20 (THE  
 MEAN OF THE NET INCOME MARGIN)

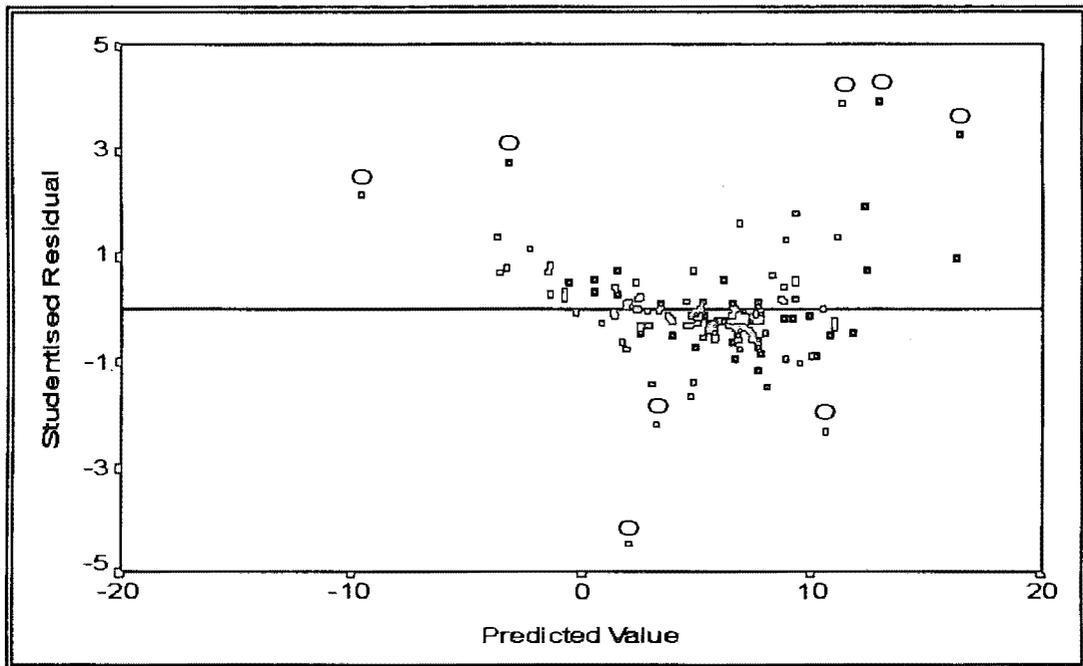


Figure 6.2 shows the residuals of the 2-step regression model for MR20 falling within a generally random configuration, moderately scattered around zero, with no strong pattern of increasing or decreasing residuals. As with MR19, a number of variables are discernible in the plot, lying beyond the five percent significance values of -1,96 and 1,96. Nonetheless, these observations were regarded as representative of the population of the data set, and retained. Accordingly, the inference from the examination of the residual plots is the verification of the aptness of the 2-step model for MR20 with regard to the regression assumptions of linearity in the overall equation, independence of residuals and constancy in the variance of the residuals over the range of the independent variables betokening homoscedasticity in the multivariate case (Hair 1992:71).

Further stepwise regression analysis was performed using only the traditional measures. A 2-step regression model produced an  $R^2$  of 0,4390 for the traditional measures with LMR14 (the log of the mean of total current liabilities divided by funds flow) displaying the same partial  $R^2$  of 0,4225. Using only alternative measures, a 1-step regression

model produced an  $R^2$  of 0,1696 from MR24 (the mean of the net liquid balance divided by total assets).

### 6.2.2.3 Regression model for the operating return on assets

The full regression model for MR21 (the mean of the operating return on assets) yields an  $R^2$  of 0,3496. This means that the maximum variance of MR21 that can be explained when all the independent variables are forced into the regression model is 34,96 percent, considerably lower than the  $R^2$ s of MR19 and MR20 (but nonetheless meaningful<sup>21</sup>). Hence the measures of liquidity included in this study are poor explanatory variables of MR21. Other measures that fall outside the scope of this study (such as those relating to capital structure) could possibly account for most of the variance in MR21. The regression results corroborate the  $\chi^2$  findings of no significant association between MR21 and the alternative independent variables (see sec 6.2.1), since this lack of association would be an indication of a weaker  $R^2$ . The results of the stepwise regression are presented in table 6.5.

TABLE 6.5  
THE RESULTS OF STEPWISE REGRESSION OF THE INDEPENDENT VARIABLES WITH  
MR21 (THE MEAN OF THE OPERATING RETURN ON ASSETS)

| Step | Variable entered   | Final model $R^2$ | Standardised regression coefficient |
|------|--|-------------------|-------------------------------------|
| 1    | LMR14 (the log of the mean of total current liabilities divided by funds flow)       | 0,1232            | -0,45                               |
| 2    | LMR12 (the log of the mean of long-term loan capital divided by net working capital) | 0,1863            | -0,32                               |
| 3    | MR24 (the mean of the net liquid balance divided by total assets)                    | 0,2389            | -0,35                               |
| 4    | MR15 (the mean of the cash conversion cycle)   | 0,2678            | -0,19                               |

The 4-step regression model for MR21 resulted in an  $R^2$  of 0,2678, indicating that a total

21 The minimum  $R^2$  that can be found statistically significant at the 0.05 significance level (corresponding to a power of .80) for a sample size of 100 is .15 for 10 independent variables and .21 for 20 independent variables (Hair 1995:104).

of 26,78 percent of the variance in MR21 can be explained by the independent variables in this model. Once again the greatest contribution (12,32%) came from LMR14 (the log of the mean of total current liabilities divided by funds flow). The estimated regression equation for MR21 can be read as:

$$MR21_e = 34,64 - 4,94LMR14 - 1,68LMR12 - 18,46MR24 - 0,03MR15$$

Accordingly, the 4-step regression model, with an  $R^2 = 0,2678$ , explains  $0,2678 / 0,3496 = 77$  percent of all variance in MR21 that can possibly be explained by the independent variables included in the study.

The interpretation of the estimated regression equation for MR21 (the mean of the operating return on assets) is as follows:

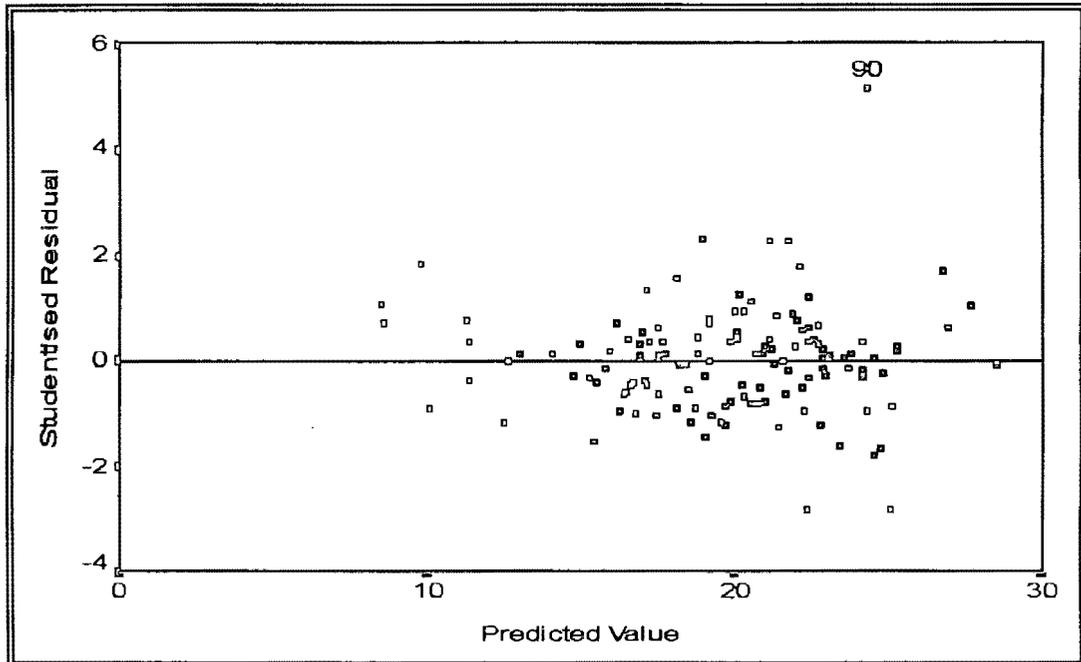
- \* A unit increase in LMR14 (the log of the mean of total current liabilities divided by funds flow [measured in years]), would produce an expected 4,94 percent decrease in MR21.
- \* A one percent increase in LMR12 ( the log of the mean of long-term loan capital divided by net working capital) would produce an expected 1,68 percent decrease in MR21.
- \* A one percent increase in MR24 (the mean of the net liquid balance divided by total assets) would produce an expected 18,46 percent decrease in MR21.
- \* A unit increase in MR15 (the mean of the cash conversion cycle [measured in days]), would produce an expected 0,03 percent decrease in MR21.

The standardised regression coefficients given in table 6.5 indicate the relative contribution of each variable within the final regression equation for MR21. LMR14 (the log of the mean of total current liabilities divided by funds flow), with a  $\beta$  of -0,45, explains 40 percent more of the variation in MR21 than LMR12, with a  $\beta$  of -0,32; LMR14 explains nearly 30 percent more of the variation in MR21 than MR24, with a  $\beta$  of -0,35; and LMR14 explains nearly 140 percent more of the variation in MR21 than MR15, with a  $\beta$  of -0,19.

The appropriateness of the regression model for MR21 was assessed by means of a

graphical analysis, that is, examination of the residuals. Figure 6.3 is a plot of the predicted values of MR21 against the studentised residuals.

FIGURE 6.3  
PLOT OF PREDICTED VALUES VERSUS STUDENTISED RESIDUALS FOR MR21 (THE  
MEAN OF OPERATING RETURN ON ASSETS)



The spread of residuals of the 4-step regression model for MR21 falls within a generally random pattern around zero, indicating the aptness of the model regarding the regression assumptions of linearity, independence of residuals and constancy of variance. Nevertheless, a single residual value of 5.35 distinguished as case number 90, was identified<sup>22</sup> as belonging to the Otis Elevator Company. The reason for this value is perceived to be the particularly low total asset values recorded over 1987 to 1988, exercising a disproportionate influence on the regression results, the  $R^2$  of which could be improved by 33 percent to 0.3785 without this value. The influential observation is however retained in the estimated regression model for MR21, the justification being that

22 This particular outlying value was identified because of its extremity from zero. In this regard, see Muil, Hamman and Smit (1992:23), who took the approach of deleting outliers beyond three standard deviations from the mean.

outliers represent the distinctive elements of the data set being studied<sup>23</sup>.

Further stepwise regression analysis was performed using only the traditional measures. A 4-step regression model produced an  $R^2$  of 0,2316 for the traditional measures with LMR14 (the log of the mean of total current liabilities divided by funds flow) displaying the same partial  $R^2$  of 0,1233. Using only alternative measures, a 1-step regression model produced an  $R^2$  of 0,0497 from LMR16 (the log of the mean of the comprehensive liquidity index). This is in agreement with the  $\chi^2$  association tests of the alternative measures<sup>24</sup>, where the highest  $\chi^2$  statistic of 1,51 (albeit not significant) was recorded between LMR16 and MR21.

#### 6.2.2.4 *Regression model for return on investment*

The full regression model for MR22 (the mean of return on investment) yields an  $R^2$  of 0,6138. This means that the maximum variance of MR22 that can be explained when all the independent variables are forced into the regression model is 61,38 percent. The results of the stepwise regression are presented in table 6.6.

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23 See again section 5.4 regarding the treatment of outliers in this study.

24 The  $\chi^2$  statistics are reflected in table 6.2.

TABLE 6.6  
THE RESULTS OF STEPWISE REGRESSION OF THE INDEPENDENT VARIABLES WITH  
MR22 (THE MEAN OF RETURN ON INVESTMENT)

| Step | Variable entered   | Final model R <sup>2</sup> | Standardised regression coefficient |
|------|--|----------------------------|-------------------------------------|
| 1    | LMR14 (the log of the mean of total current liabilities divided by funds flow)       | 0,4397                     | -0,60                               |
| 2    | LMR12 (the log of the mean of long-term loan capital divided by net working capital) | 0,4953                     | -0,24                               |
| 3    | MR15 (the mean of the cash conversion cycle)   | 0,5365                     | -                                   |
| 4    | LMR16 (the log of the mean of the comprehensive liquidity index)                     | 0,5502                     | 0,18                                |
| 5    | LMR9 (the log of the mean of inventory turnover)                                     | 0,5717                     | 0,25                                |
| 6    | MR25 (the mean of turnover divided by net working capital)                           | 0,5819                     | 0,12                                |
| 7    | MR15 (the mean of the cash conversion cycle)   | 0,5766                     | -                                   |
| 8    | LMR13 (the log of the mean of accounts receivable divided by accounts payable)       | 0,5896                     | -0,12                               |

The 8-step regression model for MR22 resulted in an R<sup>2</sup> of 0,5896, indicating that a total of 58,96 percent of the variance in MR22 can be explained by the independent variables in this model. Yet again by far the greatest contribution (43,97%) came from LMR14 (the log of the mean of total current liabilities divided by funds flow). MR15 (the mean of the cash conversion cycle) was entered into the equation in step 3, but removed again in step 7, after the admission of MR25 (the mean of turnover divided by net working capital). The presence of multicollinearity between MR15 and some of the other variables already in the equation offers a plausible explanation for the removal of MR15 in step 7.

The estimated regression equation for MR22 is:

$$MR22_e = 3,22 - 4,28LMR14 - 0,83LMR12 + 3,04LMR16 + 1,94LMR9 + 0,02MR25 - 1,04LMR13$$

Therefore, the 8-step regression model, with an R<sup>2</sup> = 0,5896, explains

$0,5896 / 0,6138 = 96$  percent of all variance in MR22 that can possibly be explained by the independent variables included in the study.

The interpretation of the estimated regression equation for MR22, the mean of return on investment, is as follows:

- \* A unit increase in LMR14 (the log of the mean of total current liabilities divided by funds flow [measured in years]), would produce an expected 4,28 percent decrease in MR22.
- \* A one percent increase in LMR12 (the log of the mean of long-term loan capital divided by net working capital) would produce an expected 0,83 percent decrease in MR22.
- \* A one percent increase in LMR16 (the log of the mean of the comprehensive liquidity index) would produce an expected 3,04 percent increase in MR22.
- \* A unit increase in LMR9 (the log of the mean of inventory turnover [measured in times]), would produce an expected 1,94 percent increase in MR22.
- \* A one percent increase in MR25 (the mean of turnover divided by net working capital) would produce an expected 0,02 percent increase in MR22.
- \* A one percent increase in LMR13 (the log of the mean of accounts receivable divided by accounts payable) would produce an expected 1,04 percent decrease in MR22.

The standardised regression coefficients given in table 6.6 indicate the relative contribution of each variable within the final regression equation for MR22. LMR14 (the log of the mean of total current liabilities divided by funds flow), with a  $\beta$  of -0,60, explains 2,5 times more of the variation in MR22 than LMR12, with a  $\beta$  of -0,24. LMR14 explains more than three times the variation in MR22 than LMR16, with a  $\beta$  of 0,18. LMR14 explains five times the variation in MR22 than MR25 and LMR13, with a  $\beta$  of 0,12 and -0,12, respectively.

The appropriateness of the regression model for MR22 was assessed by means of a graphical analysis, that is, examination of the residuals. Figure 6.4 is a plot of the predicted values of MR22 against the studentised residuals.

FIGURE 6.4  
 PLOT OF PREDICTED VALUES VERSUS STUDENTISED RESIDUALS FOR MR22 (THE  
 MEAN OF RETURN ON INVESTMENT)

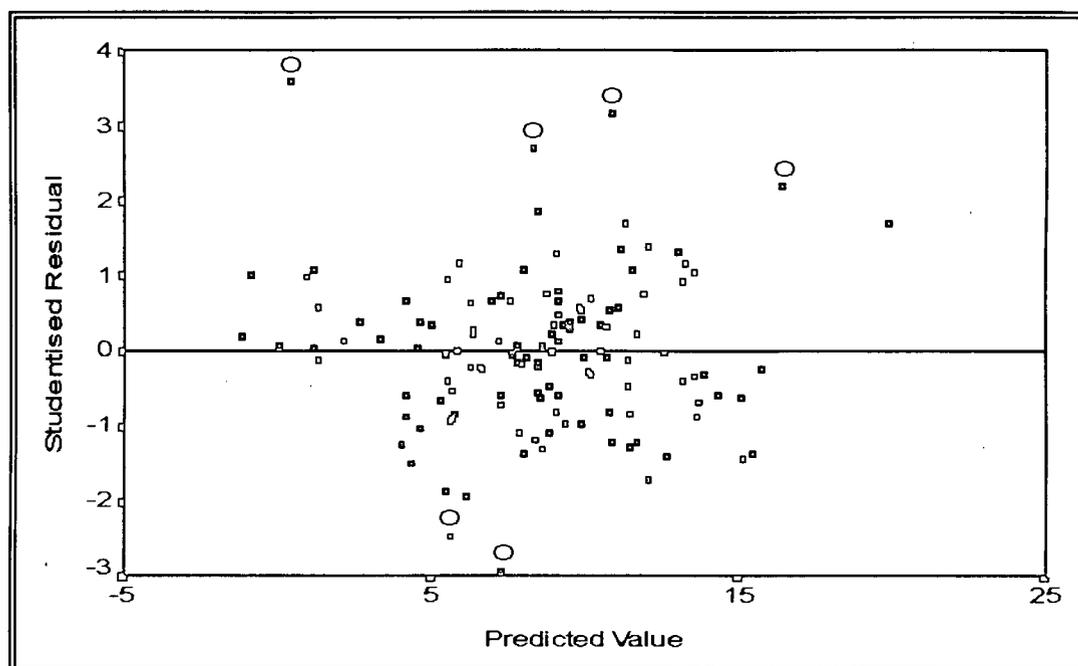


Figure 6.4 indicates that the spread of residuals of the 8-step regression model for MR22 falls within an arbitrary configuration around zero, with a number of variables lying beyond the five percent significance values of -1,96 and 1,96. These observations were nevertheless regarded as representative of the data set population, and retained. Accordingly, the aptness of the model regarding the overall regression assumptions of linearity, independence of residuals and constancy of variance was reinforced by the examination of the residual plots.

Further stepwise regression analysis was performed using only the traditional measures. A 5-step regression model produced an  $R^2$  of 0,5616 for the traditional measures with LMR14 (the log of the mean of total current liabilities divided by funds flow) displaying the same partial  $R^2$  of 0,4397. Using only alternative measures, a 2-step regression model produced an  $R^2$  of 0,2506, with MR24 (the mean of the net liquid balance divided by total assets) contributing 0,1898 in the first step, and LMR16 (the log of the mean of the comprehensive liquidity index) contributing 0,0608 in the second step.

### 6.2.2.5 Regression model for return on equity

The full regression model for MR23, the mean of return on equity, yields a disappointingly low  $R^2$  of 0,2650. Accordingly, the maximum variance of MR23 that can be explained when all the independent variables are forced into the regression model is only 26,50 percent. As in the case of MR21, this effectively means that there are other variables, not identified in this study, that account for the variance in MR23. The results of the stepwise regression are presented in table 6.7.

TABLE 6.7  
THE RESULTS OF STEPWISE REGRESSION OF THE INDEPENDENT VARIABLES WITH MR23 (THE MEAN OF RETURN ON EQUITY)

| Step | Variable entered   | Final model $R^2$ | Standardised regression coefficient |
|------|--|-------------------|-------------------------------------|
| 1    | LMR14 (the log of the mean of total current liabilities divided by funds flow)       | 0,0978            | -0,27                               |
| 2    | LMR12 (the log of the mean of long-term loan capital divided by net working capital) | 0,1325            | -0,23                               |
| 3    | MR15 (the mean of the cash conversion cycle)   | 0,1796            | -0,22                               |

The 3-step regression model for MR23 resulted in an  $R^2$  of 0,1796, indicating that a total of 17,96 percent of the variance in MR23 can be explained by the independent variables in this model, with the greatest contribution (9,78%) again from LMR14 (the log of the mean of total current liabilities divided by funds flow). The estimated regression equation for MR23 can be read as:

$$MR23_e = 31,91 - 4,27LMR14 - 1,70LMR12 - 0,05MR15$$

Therefore, the 3-step regression model, with an  $R^2 = 0,1796$ , explains  $0,1796 / 0,2650 = 68$  percent of all variance in MR23 that can possibly be explained by the independent variables included in the study.

The interpretation of the estimated regression equation for MR23 (the mean of return on equity) is as follows:

\* A unit increase in LMR14 (the log of the mean of total current liabilities divided

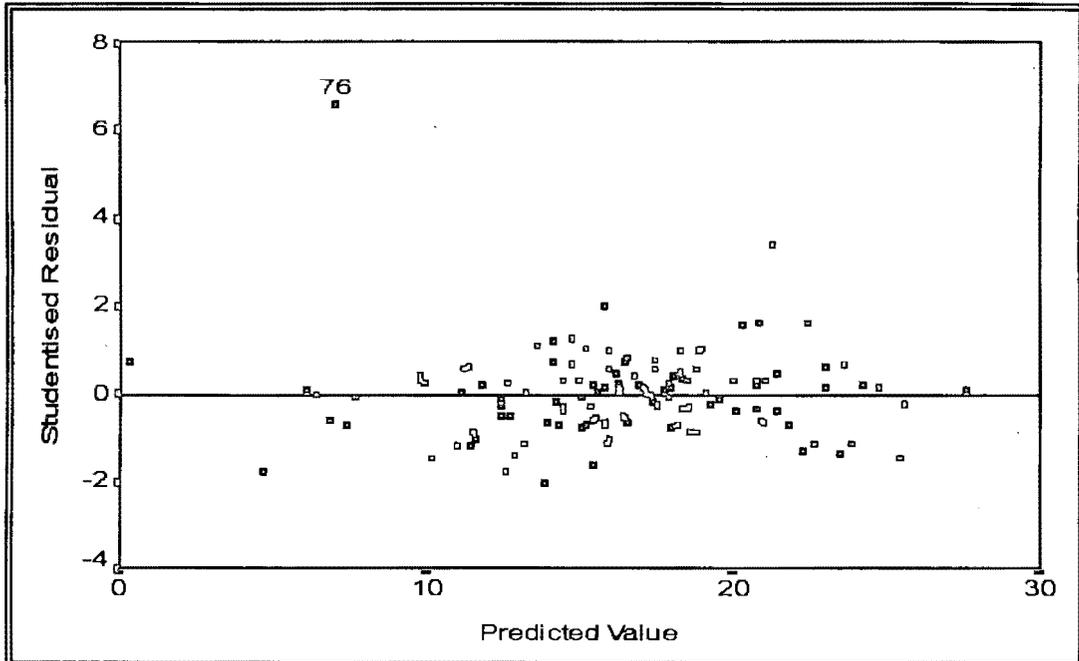
by funds flow (measured in years)), would produce an expected 4,27 percent decrease in MR23.

- \* A one percent increase in LMR12 (the log of the mean of long-term loan capital divided by net working capital) would produce an expected 1,70 percent decrease in MR23.
- \* A unit increase in MR15 (the mean of the cash conversion cycle [measured in days]), would produce an expected 0,05 percent decrease in MR23.

The standardised regression coefficients given in table 6.7 indicate the relative contribution of each variable within the final regression equation for MR23. LMR14 (the log of the mean of total current liabilities divided by funds flow), with a  $\beta$  of -0,27, explains 17 percent more of the variation in MR23 than LMR12, with a  $\beta$  of -0,23; and LMR14 explains 23 percent more of the variation in MR23 than MR15, with a  $\beta$  of -0,22.

The appropriateness of the regression model for MR23 was assessed by means of a graphical analysis, that is, examination of the residuals. Figure 6.5 is a plot of the predicted values of MR23 against the studentised residuals.

FIGURE 6.5  
 PLOT OF PREDICTED VALUES VERSUS STUDENTISED RESIDUALS FOR MR23 (THE  
 MEAN OF RETURN ON EQUITY)



The spread of residuals of the 3-step regression model for MR23 falls within a generally random pattern, indicating the aptness of the model regarding the overall regression assumptions of linearity, independence of residuals and constancy of variance. Figure 6.5 features an outlying studentised residual value of 6.61, distinguished as case number 76, and identified<sup>25</sup> as appertaining to Mathieson and Ashley Holdings. The reason for this value is perceived to be the negative minority interest values recorded over the period 1988 to 1989, with subsequent major changes in capital structure, thereby exercising a disproportionate influence on the regression results, the  $R^2$  of which could be improved by 52 percent to 0,3476 without this value. The influential observation is however retained in the estimated regression model for MR23<sup>26</sup>.

Further stepwise regression analysis was performed using only the traditional measures.

25 See previous footnote 22 in this chapter.

26 This is consistent with treatment of outliers in this study, as explained in section 5.4.

A 4-step regression model produced an  $R^2$  of 0,1860<sup>27</sup> for the traditional measures with LMR14 (the log of the mean of total current liabilities divided by funds flow) displaying the same partial  $R^2$  of 0,0978. Using only alternative measures, a 2-step regression model produced an  $R^2$  of 0,1151, with MR24 (the mean of the net liquid balance divided by total assets) contributing 0,0930 in the first step, and LMR16 (the log of the mean of the comprehensive liquidity index) contributing 0,0221 in the second step.

#### 6.2.2.6 Overall summary of regression results

A summary of the regression models for each dependent variable formulated by the stepwise procedure is considered appropriate at this point. The estimated regression equations for the five dependent variables are:

$$MR19_e = 28,40 - 7,39LMR14 - 5,53LMR11 + 0,04MR18 + 0,62LMR12$$

$$MR20_e = 12,48 - 5,15LMR14 + 7,67MR24$$

$$MR21_e = 34,64 - 4,94LMR14 - 1,68LMR12 - 18,46MR24 - 0,03MR15$$

$$MR22_e = 3,22 - 4,28LMR14 - 0,83LMR12 + 3,04LMR16 + 1,94LMR9 + 0,02MR25 - 1,04LMR13$$

$$MR23_e = 31,91 - 4,27LMR14 - 1,70LMR12 - 0,05MR15$$

The estimated regression equations for the five dependent variables indicate that LMR14 (the log of the mean of total current liabilities divided by funds flow) enters first into each of the regressions. The standardised regression coefficient values reflect the same results, with LMR14 consistently explaining relatively larger variations in the dependent variables than any of the other independent variables. The estimated regression equations further indicate that the most frequently occurring independent variable after LMR14 is LMR12 (the log of the mean of long-term loan capital divided by net working capital) present in all equations except for MR20, and entering second into the equations for MR21, MR22 and MR23. The clear inference is that the working capital measures accounting for the largest variation in the dependent variables are both traditional working capital leverage measures described in section 4.3.1.3.

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27 This indicates that by using only traditional measures, a higher variance in MR23 is, in fact, explained, albeit a mere 0,6 percent improvement in the  $R^2$  from 0,1796 to 0,1860.

The alternative working capital measures of MR15 (the mean of the cash conversion cycle) and MR24 (the mean of the net liquid balance divided by total assets) both appeared in two regression equations. LMR11 (the log of the mean of the accounts payable turnover), LMR13 (the log of the mean of accounts receivable divided by accounts payable), LMR16 (the log of the mean of the comprehensive liquidity index), MR18 (the mean of the net trade cycle) and MR25 (the mean of turnover divided by net working capital) each entered into only one of the regression equations. LMR6 (the log of the mean of the current ratio), LMR7 (the log of the mean of the quick ratio) and LMR10 (the log of the mean of the accounts receivable turnover) were not entered into any of the regression equations. Thus for the firms in this data set, the traditional measures of LMR6, LMR7 and LMR10 do not contribute towards the variation in their returns.

When stepwise regression was undertaken using only alternative measures, MR24 (the mean of the net liquid balance divided by total assets) and LMR16 (the log of the mean of the comprehensive liquidity index) featured the most prominently, with MR18 entering only once, and MR15 not entering into any of the equations. A feasible explanation for the latter would be the presence of multicollinearity between MR15 and the variables already in the equations.

Also notable is that the plus or minus sign preceding the coefficients in the regression equations did not always indicate the same relationship as the chi-square results in section 6.2.1. For instance, the regression coefficient for LMR12 (the log of the mean of long-term loan capital divided by net working capital) is negative in the regression equations where it enters in the second step, but table 6.1 indicates a positive relationship between the variables. One possible explanation for differences in the sign of the coefficient is that the chi-square test is a one-on-one comparison, whereas the regression equation is a reflection of the 'total' picture, in conjunction with all variables. In this latter context, the contribution of LMR12 is reflected by a predominantly negative regression coefficient, which conforms to the theory that a lower R12 - that is, long-term loan capital divided by net working capital - is preferable. The regression coefficient of LMR14 (the log of the mean of total current liabilities divided by funds flow) always reflects the expected negative sign, also in agreement with theoretical conjecture, which

favours a lower R14, the ratio of total current liabilities divided by funds flow.

Table 6.8 is a summary of the coefficients of determination ( $R^2$  values) of all the dependent variables as explained in terms of the independent variables in the study, and the contribution of LMR14 towards explaining the variance in each of the dependent variables.

**TABLE 6.8**  
**SUMMARY OF THE  $R^2$  VALUES OF THE DEPENDENT VARIABLES AS EXPLAINED BY THE INDEPENDENT VARIABLES**

| Dependent variable                                | $R^2$  | Contribution of LMR14 |
|---|--------|-----------------------|
| MR19 (the mean of the operating income margin)    | 0,5739 | 0,4475                |
| MR20 (the mean of the net income margin)          | 0,4490 | 0,4225                |
| MR21 (the mean of the operating return on assets) | 0,2678 | 0,1232                |
| MR22 (the mean of return on investment)           | 0,5896 | 0,4397                |
| MR23 (the mean of return on equity)               | 0,1796 | 0,0978                |

The highest  $R^2$ s are notably for MR19, MR20 and MR22, with MR19 a pretax measure of return, and the other two aftertax return measures. The regression tests for association did not reveal any noticeable divergences or patterns between pretax and aftertax dependent measures and the independent variables. More prominent are the results, supporting the  $R^2$  findings, of a principal component analysis test undertaken in the exploratory analysis, with a view to reducing the dimensionality of the data set.

Principal component analysis entails the creation of a new set of a reduced number of variables called "principal components" that account for the maximum variance in the data set. Each principal component is a linear combination of the original variables, with coefficients equal to the eigenvectors of the correlation matrix (Kotz & Johnson 1986:181-182). On the evidence of their eigenvector scores, the dependent variables that contributed the most to the dimensionality were LMR22, LMR20 and LMR19. Hence it was anticipated that these three dependent variables would have the most substantial  $R^2$ s.

The results of the stepwise regression indicate that of all the independent variables comprising traditional and alternative working capital measures, LMR14 (the log of the

mean of total current liabilities divided by funds flow) ubiquitously exhibits the greatest  $R^2$ s for each of the dependent variables. This is hardly surprising considering the presence of the income element in both the dependent and independent variables, albeit in the numerator in the former, and the denominator in the latter. A method of dealing with the common source component (present to a greater or lesser degree in all of the variables derived from the standardised financial statements) would be to select a dependent variable which is not an accounting return, and therefore autonomous from the balance sheet ratios used in the study.

One such measure is market return, defined as (closing share price - opening share price) plus annual dividend. In considering market return for the participating firms for the 10 years under review, major adjustments need to be constituted to the data in order to account for share splits and thin trading (the latter, particularly, is well recognised as a factor which impacts on estimation procedures on the JSE<sup>28</sup>). These adjustments would entail the elimination of too many participating firms, and so invalidate subsequent meaningful test results on the data. Accordingly, the use of such a measure falls outside the scope of this study.

#### *6.2.2.7 Assessing estimating patterns using 1994 data*

Once 1994 BFA balance sheet data on the industrial firms became available, it was used to observe the estimating patterns of the regression models, and to comment on this. Data were obtained on 130 of the 135 firms<sup>29</sup>. Three of the 130 firms were eliminated on the grounds of abnormal extraordinary income reported in 1994<sup>30</sup>, causing distortions in the ratios. This left 127 firms with 1994 data, for which the actual values of the independent variables were substituted into the regression equations to procure estimated return values for the dependent variables, which could be compared with the 1994 observed values.

The regression models for MR19 (the mean of the operating income margin) and MR20

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28 See Bowie and Bradfield (1993:7) for research regarding thin trading on the JSE.

29 The other five firms did not have 1994 data available at that stage, or were in the process of being delisted.

30 These firms were Lionmatch, McPhail and Utico.

(the mean of the net income margin) exhibited a tendency to overestimate, when compared to observed values, with specific reference to 1994 data. A comment here is that both MR19 and MR20 are returns relating to sales. A possible explanation for the overestimation could be that profit margins relating to sales declined in 1994, in relation to the previous 10 years. On comparing the arithmetic mean of the operating income margin for the years 1984 to 1993<sup>31</sup> with the arithmetic mean for 1994, it was found that the mean had in fact declined from 12,78 for the 10 years to 11,67 for 1994. Correspondingly, the arithmetic mean for the net income margin also declined from 5,59 for the 10 years to 5,43 for 1994.

The regression models for MR21 (the mean of the operating return on assets) MR22 (the mean of return on investment) and MR23 (the mean of return on equity) displayed greater precision in estimating the return values using 1994 data, indicating a more even spread of estimated values. The estimating patterns of the regression models were examined using 1994 data, to assess regression models based on the mean of 10 years data, where the influence of cyclical fluctuations would not be as prominent as in a single year. Accordingly, one would expect differences between the expected and observed values.

### 6.2.3 Resolution regarding hypothesis 1

Hypothesis 1 of the study states that traditional and alternative working capital measures associate differently with firm returns. The chi-square tests for association conducted in section 6.2.1 revealed that the traditional working capital measures, in particular working capital leverage measures, associate more strongly with firm returns than the alternative working capital measures. The regression models built for each return measure<sup>32</sup> supported the chi-square findings and quantified the associations between the working capital measures and returns. Therefore, based on the results of the chi-square and regression techniques applied, hypothesis 1 of the study is accepted.

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31 See appendix D for univariate measures of variables R1 to R25 aggregated for the 10 years.

32 These models were reported in section 6.2.2.

### 6.3 STATISTICAL TESTING OF HYPOTHESIS 2

Hypothesis 2 of the study states that there is a significant size effect on the working capital measures employed by South African listed industrial firms. In other words, the working capital measures employed by large South African industrial firms differ significantly from those employed by small South African industrial firms. In empirical studies, it is important to adopt an acceptable, consistent definition of firm size, and variables such as number of employees, sales turnover, profitability or total assets are often used in research studies (Ray & Hutchinson 1983:1). In this study, firm size was defined according to the value of total assets in 1993. This measure was chosen for the following reasons:

- \* It is the primary measure applied by the *Financial Mail's* top 100 companies survey rating of the most successful South African firms.
- \* By concurrence, a dichotomous classification of participating firms into 'large' and 'small' was discerned.
- \* Data on total assets were readily available.

In order to statistically verify the hypothesis of a significant size effect, use was made of the SAS t-test procedure. The t-test evaluates the statistical significance of the disparity between two independent sample means, calculating a t-statistic, which is the ratio of the difference between the sample means to its standard error. The null hypothesis of no significant difference between the means of the two groups would be rejected for large absolute values of the t-statistic, the critical value of which is ascertained by referring to Student's t-distribution with  $(N_1 + N_2 - 2)$ <sup>33</sup> degrees of freedom (Hair et al 1992:162-163).

The SAS PROC T-TEST command was used to test for a size effect on the participating firms, classified dichotomously, whether or not they were one of the *Financial Mail's* (1993) top 100 firms when ranked according to total assets. Sixty-eight of the 135 firms-were in the 1993 Top 100 (Group 1), and 67 firms were not (Group 2). The critical

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33  $N_1 + N_2$  refer to the sample sizes - that is - 68 firms in Group 1 and 67 firms in Group 2.

value at the 95 percent confidence level for more than 120 degrees of freedom is 1,96<sup>34</sup> (Lapin 1990:952). Hence, t-statistics which are  $> 1,96$  or  $< -1,96$  will mean rejection of the null hypothesis. Table 6.8 presents the t-statistics for the dichotomous groups for the traditional and alternative working capital measures.

TABLE 6.9  
t-STATISTICS FOR TRADITIONAL AND ALTERNATIVE WORKING CAPITAL MEASURES FOR DIFFERENCES IN THE MEANS BETWEEN SIZE GROUPS 1 AND 2

| VARIABLE | NUMBER OF OBSERVATIONS |         | t-STATISTIC | PROB >  t |
|----------|------------------------|---------|-------------|-----------|
|          | GROUP 1                | GROUP 2 |             |           |
| LMR6     | 68                     | 67      | -0,27       | 0,79      |
| LMR7     | 68                     | 67      | -0,41       | 0,68      |
| LMR9     | 65                     | 64      | -1,10       | 0,28      |
| LMR10    | 65                     | 64      | 0,27        | 0,79      |
| LMR11    | 65                     | 64      | -1,32       | 0,19      |
| LMR12    | 67                     | 67      | 1,30        | 0,20      |
| LMR13    | 68                     | 67      | -1,18       | 0,24      |
| LMR14    | 68                     | 67      | -2,17       | 0,03      |
| MR25     | 66                     | 64      | -0,81       | 0,42      |
| MR15     | 65                     | 64      | -1,10       | 0,28      |
| LMR16    | 66                     | 64      | 0,56        | 0,58      |
| MR18     | 65                     | 64      | -1,13       | 0,26      |
| MR24     | 68                     | 67      | 1,72°       | 0,09°     |

The values in table 6.9 can be interpreted as follows: at the 95 percent confidence level, for the participating firms, variable LMR6 (the log of the mean of the current ratio) has a t-statistic of -0,27, with a probability of 79 percent that there is no significant difference between the means of Group 1 and Group 2 for LMR6. Correspondingly, MR24 (the mean of the net liquid balance divided by total assets) has a t-statistic of 1,72, with a nine percent possibility of no significant difference between the means of Group 1 and Group 2 for MR24.

Table 6.8 indicates that the only variable with a t-statistic greater than the critical value

34 A two-sided t-test was performed.

of 1.96 is LMR14 (the log of the mean of total current liabilities divided by funds flow [shaded]), with MR24 (the mean of the net liquid balance divided by total assets) displaying the next closest statistic<sup>35</sup>(asterisk). These findings are probably due to the fluctuations of these measures with the economic indicators over time, as reflected in figures 5.4 and 5.5. The results of this t-test suggest that the null hypothesis of no significant differences between the means of the two groups would be accepted for all variables with the exception of LMR14 (and possibly MR24). These findings of no significant size effect are in agreement with those of Bosch and Du Plessis (1994:11), who (using multiple analysis of variance) found that firm size had no influence on the use of specific categories of financial ratios, whilst conceding that their results could have been due to relatively small observation sizes.

A rationalisation for the dearth of significant t-values in this study, indicating differences in the means of large and small firms, is that relative measures have been used. For instance, the variable MR24<sup>36</sup> has already been divided by total assets. Also, the grouping of firms into 'Group 1' and 'Group 2' might not be sufficiently extreme in that the 'biggest' and 'smallest' of all the participating firms are not identified. To this end, a further t-test was performed by first ranking the participating firms per total assets from highest to lowest. The top quartile of firms was then compared with the bottom quartile, effectively eliminating the core 50 percent band of observations. The idea was to contrast the largest (HIGH group) against the smallest (LOW group) of participating firms. Table 6.10 indicates the t-values of the 'HIGH' and 'LOW' groups.

As anticipated, table 6.10 manifests more instances of a significant size effect<sup>37</sup> on the working capital measures of the 'HIGH' group compared to the 'LOW' group. In particular, the traditional measures of LMR11 (the log of the mean of the accounts payable turnover), LMR12 (the log of the mean of long-term loan capital divided by net working capital), LMR13 (the log of the mean of accounts receivable divided by accounts payable) and LMR14 (the log of the mean of total current liabilities divided by funds

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35 The difference between the means of Group 1 and Group 2 are significant at the 10 percent level for MR24.

36 MR24 is the mean of the net liquid balance divided by total assets.

37 Instances significant at the five percent level are shaded, and those significant at the 10 percent level are indicated by \*.

flow); and the alternative measures of MR15 (the mean of the cash conversion cycle) and MR18 (the mean of the net trade cycle) indicate significant t-statistics at the five percent level. LMR6 (the log of the mean of the current ratio) and LMR7 (the log of the mean of the quick ratio) indicate significant t-statistics at the 10 percent level. For these variables - LMR6, LMR7, LMR11 to LMR14, MR15 and MR18 - the null hypothesis of no significant differences in the means between the size groups, may be rejected.

TABLE 6.10  
t-STATISTICS FOR TRADITIONAL AND ALTERNATIVE WORKING CAPITAL MEASURES FOR DIFFERENCES IN THE MEANS BETWEEN SIZE GROUPS 'HIGH' AND 'LOW'

| VARIABLE | NUMBER OF OBSERVATIONS |           | t-STATISTIC | PROB >  t |
|----------|------------------------|-----------|-------------|-----------|
|          | GROUP HIGH             | GROUP LOW |             |           |
| LMR6     | 34                     | 34        | 1.79°       | 0.08°     |
| LMR7     | 34                     | 34        | 1.75°       | 0.09°     |
| LMR9     | 30                     | 34        | 1.11        | 0.27      |
| LMR10    | 30                     | 34        | -1.20       | 0.23      |
| LMR11    | 30                     | 34        | 2.53        | 0.01      |
| LMR12    | 34                     | 34        | -3.71       | 0.00      |
| LMR13    | 34                     | 34        | 3.48        | 0.00      |
| LMR14    | 34                     | 34        | 2.35        | 0.02      |
| MR25     | 30                     | 34        | -0.30       | 0.76      |
| MR15     | 30                     | 34        | 2.33        | 0.02      |
| LMR16    | 30                     | 34        | 0.15        | 0.88      |
| MR18     | 30                     | 34        | 2.37        | 0.02      |
| MR24     | 34                     | 34        | -1.70       | 0.09      |

It would be expected that firms from the 'HIGH' group would also be from Group 1 (ie top 100), and firms from the 'LOW' group would be from Group 2 (not top 100). This was assessed by means of a two-way contingency table, the results of which indicated, as anticipated, that most values fell into the correct quadrants - that is, most 'LOW' firms were not in the top 100 group (33 out of 34 firms), and most 'HIGH' firms were (31 out of 34 firms).

The results of the t-tests for size effects were compared to other research findings on

firm size. Findings of a study by Osteryoung et al (1992:45) revealed that the liquidity ratios of current ratio (R6), quick ratio (R7) and accounts receivable turnover (R10) did not differ across large and small firms. However, the study did find significant mean differences in the leverage ratios of large and small firms. Osteryoung et al's findings agree with the statistics in table 6.10 indicating no significant differences regarding LMR10 (the log of the mean of the accounts receivable turnover) and registering significant differences in the leverage measures of LMR12 (the log of the mean of long-term loan capital divided by net working capital), LMR13 (the log of the mean of accounts receivable divided by accounts payable) and LMR14 (the log of the mean of total current liabilities divided by funds flow). Fieldsend et al (1987: 513-514) found that as firms become larger, the current ratio (R6) tends towards the industry average. In this study, the extreme size test found differences in the current and quick ratios between the largest and the smallest of the participating firms at the 10 percent level of significance.

Based on the t-test results, hypothesis 2, regarding significant size effect on the working capital measures employed by South African listed industrial firms, would not be unconditionally accepted. Where the size dichotomy is applied more stringently, hypothesis 2 is accepted for six<sup>38</sup> of the 13 working capital measures, indicating differences between the means of firms in the top and bottom size quartiles, at the five percent level of significance. Hypothesis 2 would also be accepted for two<sup>39</sup> of the 13 measures, indicating differences between the means of firms in the top and bottom size quartiles, at the 10 percent level of significance.

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38 These measures are LMR11 (the log of the mean of accounts payable turnover), LMR12 (the log of the mean of long-term loan capital divided by net working capital), LMR13 (the log of the mean of accounts receivable divided by accounts payable), LMR14 (the log of the mean of total current liabilities divided by funds flow), MR15 (the mean of the cash conversion cycle) and MR18 (the mean of the net trade cycle).

39 These measures are LMR6 (the log of the mean of the current ratio) and LMR7 (the log of the mean of the quick ratio).

#### 6.4 STATISTICAL TESTING OF HYPOTHESIS 3

Hypothesis 3 of the study states that there is a significant sector effect on the working capital measures employed by South African listed industrial firms. This implies that the working capital measures employed by the participating firms differ across the 16 sectors. The number of participating firms per sector is given in table 5.1, indicating that the number of firms per sector ranges from a maximum of 22 industrial holding firms to a minimum of one steel and allied firm, manifesting a paucity of participants in several sectors.

The appropriate statistical technique to assess hypothesis 3 is ANOVA or MANOVA. However, sample size is critical to this procedure. Hair et al (1992:444) are of the view that 'while there is no correct sample size, recommendations are for a size ranging between 100 and 200'. Because of the lack of number of firms per sector<sup>40</sup>, a nonparametric procedure was considered appropriate to test hypothesis 3. Nonparametric tests make no assumptions about the distribution of the data set, and whether the transformed data set or the original mean variables are used, the same results may be expected, due to the ranking procedure of the test envisaged.

The Mann-Whitney U test is the nonparametric alternative to the t-test applied in section 6.2. Here it can be used to test that two independent samples come from populations with the same mean, where the actual values of the data are replaced by ranks. Where there are more than two groups<sup>41</sup>, the Kruskal-Wallis test verifies whether several independent groups come from populations with the same mean, again with the actual values of the data replaced by ranks<sup>42</sup> (Unisa statistics guide for STA305-T 1990:117). The SAS PROC NPAR1WAY command was used, with JSE sector as the class variable, to calculate simple linear rank statistics based on Wilcoxon scores<sup>43</sup>. These statistics were used to test if the distribution of a variable has the same location parameter across different groups (SAS/stat user's guide 1990b:1196).

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40 This is not an unusual phenomenon on the JSE. See Muil et al (1992:23-28) in this regard.

41 In this case there are 16 sectors.

42 The Kruskal-Wallis test is analogous to the parametric ANOVA procedure.

43 These are rank sums.

The statistical null hypothesis,  $H_0$ , is that the location of the distributions is the same, that is, there is no sector effect. The test produces a chi-square approximation (CHISQ) for testing  $H_0$  and the asymptotic significance probability ( $\text{prob} > \text{CHISQ}$ ), the values of which for each traditional and alternative working capital measure are reflected in table 6.11. The critical value at the five percent level of significance for 15 degrees of freedom<sup>44</sup> is 24,99 (Lapin 1990:961).

The values in table 6.11 can be interpreted as follows: for the participating firms, for variable LMR6 (the log of the mean of the current ratio) with a CHISQ score of 29,87, there is only a 1,24 percent chance that no significant differences occur in the means of the distributions of the variable across the sectors. Analogously, for variable LMR13 (the log of the mean of accounts receivable divided by accounts payable) with a CHISQ score of 35,71, there is (practically) a zero percent chance of no significant difference in the means of the distributions of the variable across the sectors. For MR25 (the mean of turnover divided by net working capital) with a CHISQ score of 8,35, there is a 91 percent chance that there are no significant differences between the means of the distributions of the variable across the sectors.

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44 The degrees of freedom are represented by the 16 sectors - 1.

TABLE 6.11  
KRUSKAL-WALLIS TEST SCORES FOR SECTOR EFFECT

| VARIABLE | CHSQ   | Prob > CHSQ |
|----------|--------|-------------|
| LMR6     | 29.57  | 0.0124      |
| LMR7     | 22.94° | 0.0355      |
| LMR9     | 46.50  | 0.0001°     |
| LMR10    | 42.76  | 0.0002°     |
| LMR11    | 37.97  | 0.0009°     |
| LMR12    | 21.26  | 0.1286      |
| LMR13    | 35.71  | 0.0019°     |
| LMR14    | 33.47  | 0.0103      |
| MR25     | 8.35   | 0.9090      |
| MR15     | 44.72  | 0.0001°     |
| LMR16    | 16.20  | 0.3686      |
| MR18     | 45.00  | 0.0001°     |
| MR24     | 24.67° | 0.0545      |

The shaded values in table 6.11 indicate the instances where the null hypothesis is rejected, at the five percent level of significance, for all variables except LMR7 (the log of the mean of the quick ratio) where the null hypothesis would be rejected at the 10 percent level of significance. Concurringly, only three of the 13 working capital measures in table 6.11 do not exhibit any significant sectoral effect, namely LMR12 (the log of the mean of long-term loan capital divided by net working capital), MR25 (the mean of turnover divided by net working capital) and LMR16 (the log of the mean of the comprehensive liquidity index).

The inference from this test is that there are significant differences in the means of the variables across the sectors (ie a significant sector effect) for 10 of the 13 working capital measures tested, at the 95 and 90 percent confidence levels. These findings are compared to three other studies that considered industry (ie sector) effects. Research conducted by Hawawini, Viallet and Vora (1986:23) on industry influence on corporate working capital decisions reported a significant industry effect on a firm's investment in working capital for all 19 years covered by their study. Similarly, in a local study, Jordaan et al (1994:71) referred to the influence of the possible 'sector specific characteristics'

on their findings on the distributional properties of financial ratios. Thirdly, research by Fieldsend et al (1987:513) concluded that considerable digression from proportionality was accounted for by industry influence.

The results regarding significant sector effect should not be accepted without considering that the 13 independent variables were evaluated in individual ranking procedures, each time using a five percent significance level. This creates a problem when attempting to control the overall type 1 error rate. Across 13 separate tests, the probability of a type 1 error<sup>45</sup> will lie somewhere between five percent and  $1 - .95^{13} = .49$ , signifying a 49 percent chance of making a type 1 error (Hair et al 1992:157).

In order to ensure an overall level of significance of five percent, we can compare the p-value (ie, the {Prob > CHISQ} value) of each of the variables to  $q$  (instead of comparing them to  $\alpha = 0,05$ ), where  $q = \alpha/z$ ; and  $z =$  number of response variables<sup>46</sup>. So, the exceedence probability for an overall five percent level of significance is no longer 0,05, but rather  $0,05/13 = 0,0039$ <sup>47</sup>. It is then observed that in table 6.11, at an overall five percent level of significance, six (instead of 10) of the 13 variables exhibit significant exceedence probabilities, marked with an asterisk.

Hence, rejection of the statistical null hypothesis, indicating differences in the means of the variables across sectors, is feasible, for six out of the 13 working capital measures tested. Based on the Kruskal-Wallis test scores, at an overall five percent level of significance, hypothesis 3 of the study regarding significant sector effect on the working capital measures employed by South African listed industrial firms, would be accepted for six out of the 13 variables, that is, for 46 percent of the working capital measures.

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45 A type 1 error is the probability of rejecting the null hypothesis when it should be accepted.

46 In this case there are 13 variables.

47 The more individual tests performed, the smaller the exceedence probability will be.

## 6.5 SUMMARY

The focus of this chapter was on the data confirmation step undertaken in the study of the association between working capital measures and recognised measures of return. The approach followed was to address the three research hypotheses of the study by means of the statistical methods employed in the testing for acceptance or rejection of each hypothesis.

Hypothesis 1 asserts that traditional and alternative working capital measures associate differently with firm returns. The statistical tools applied to verify this hypothesis were the chi-square test for association, followed by regression analysis, with a view to quantifying the underlying relationships between the independent and dependent variables.

The chi-square test for association was essayed using the medians of the independent and dependent measures to compute the statistics for the two-dimensional contingency tables. The highest  $\chi^2$  statistics, indicating strongest association, were recorded between LMR14 (the log of the mean of total current liabilities divided by funds flow) and the return measures, with negative association in all instances. These findings are not altogether surprising, considering the income element present in the denominator of R14 (total current liabilities divided by funds flow) and in the numerator of the return measures. The negative associations recorded correspond with the theory which states that a smaller R14 is preferable to a larger one. In contrast, LMR6 (the log of the mean of the current ratio) and LMR7 (the log of the mean of the quick ratio) manifested positive associations with the return measures, findings which, albeit contrary to normative concepts, support those of other research<sup>48</sup>.

The  $\chi^2$  statistics afforded convincing manifestation of both positive and negative association between the working capital measures and the return measures by assessing the strength of association between the independent and dependent variables. Significant association occurred more frequently between the traditional working capital measures and measures of return than between the alternative working capital measures and the

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48 Namely Kamath (1989:28).

measures of return.

Regression analysis was undertaken to further explore the association between the working capital measures and return measures, by describing the values of the dependent variables in terms of the independent variables. Stepwise forward regression produced regression models for each of the dependent variables, the  $R^2$ s of which ranged from a minimum of 0,1796 for MR23 (the mean of return on equity) to a maximum of 0,5896 for MR22 (the mean of return on investment). As expected, LMR14 (the log of the mean of total current liabilities divided by funds flow) emerged as by far the greatest contributor in the explanation of the variance in each of the five regression equations, with the expected negative sign for the regression coefficient in all instances.

These findings were supported by the standardised regression coefficients for the independent variables, which indicated that for each of the dependent variables, the  $\beta$  of LMR14 (the log of the mean of total current liabilities divided by funds flow) was by far the greatest. This indicates that LMR14 made the largest relative contribution to the explanation of the variance in each of the dependent variables.

The most recurrent measure in the regression equations after LMR14 was LMR12 (the log of the mean of long-term loan capital divided by net working capital) which entered into every regression equation except that of MR20 (the mean of the net income margin). The significant point here is that the working capital measures accounting for the largest variation in the dependent variables are both traditional working capital leverage measures.

The traditional working capital position ratios, namely LMR6 (the log of the mean of the current ratio) and LMR7 (the log of the mean of the quick ratio) and the working capital activity ratio of LMR10 (the log of the mean of the accounts receivable turnover) were not entered into any of the regression equations. The other working capital activity ratios of LMR9 (the log of the mean of inventory turnover), LMR11 (the log of the mean of the accounts payable turnover) and MR25 (the mean of turnover divided by net working capital) were singly entered into only one of the regression equations.

The alternative working capital measures of MR15 (the mean of the cash conversion cycle), LMR16 (the log of the mean of the comprehensive liquidity index) and MR24 (the mean of the net liquid balance divided by total assets) each appeared in two of the regression equations, and MR18 (the mean of the net trade cycle) in one of the regression equations. Stepwise regression using only alternative measures, featured MR24 (the mean of the net liquid balance divided by total assets) and LMR16 (the log of the mean of the comprehensive liquidity index) most prominently, while MR15 was not entered into any of the equations.

The regression models were assessed using 1994 data by substituting the actual values of the independent variables into the five regression models in order to comment on estimation patterns. The results indicated that the regression models for MR19 and MR20 tended to overestimate, whereas the models for MR21, MR22 and MR23 indicated a more even spread of estimated values.

On the basis of the results of the chi-square and multiple regression procedures, hypothesis 1 of the study was accepted.

Hypothesis 2 of the study contends that there is a significant size effect on the working capital measures employed by South African listed industrial firms. This hypothesis was tested by means of a t-test, which evaluated the statistical significance of the divergence between the sample means of the participating firms, classified dichotomously, whether or not they were one of the *Financial Mail's* (1993) top 100 firms when ranked according to total assets.

The t-statistics exhibited no significant differences in the means of the two groups of participating firms for 12 out of the 13 working capital measures. A likely reason for the scarcity of significant t-values, indicating differences in the means of large and small firms, is the presence of relativity in the measures used in the study. An additional t-test was performed in an effort to compare only the top quartile of participating firms with the bottom quartile of participating firms. As anticipated, these test statistics exhibited more instances of significant size effect on the working capital measures, this time for eight out of the 13 working capital measures.

Based on the results of the t-tests for significant size effect, hypothesis 2 of the study would not be unconditionally accepted. Where the size dichotomy is not applied stringently, hypothesis 2 would be rejected for all working capital measures with the exception of LMR14 (the log of the mean of total current liabilities divided by funds flow). Where the size dichotomy is applied more stringently, hypothesis 2 is accepted for six<sup>49</sup> of the 13 working capital measures, indicating differences between the means of firms in the top and bottom size quartiles, at the five percent level of significance. Hypothesis 2 would also be accepted in this case for two<sup>50</sup> of the 13 measures, at the 10 percent level of significance.

Hypothesis 3 of the study states that there is a significant sector effect on the working capital measures employed by South African listed industrial firms. The paucity in numbers of participating firms in many of the 16 sectors precluded the application of parametric procedures to test this hypothesis. The nonparametric alternative to the t-test for more than two groups is the Kruskal-Wallis test, with the actual values of the data being replaced by ranks.

The p-values of the test indicated that the statistical null hypothesis of no sector effect could be rejected for 10 out of the 13 working capital measures, indicating significant differences in the means of the variables over the sectors. A problem with these findings is the deficiency in control over the type 1 error rate. When regulating for an overall five percent level of significance, a significant sector effect was found for six (rather than 10) of the working capital measures.

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49 Footnote 38 of this chapter lists these measures.

50 Footnote 39 of this chapter lists these measures.

In summation, hypothesis 1, which states that the traditional and alternative working capital measures of South African listed industrials associate differently with firm returns, is accepted. Hypothesis 2, which states that there is a significant size effect on the working capital measures employed by South African listed industrial firms, is accepted conditionally for eight<sup>51</sup> of the 13 variables. Hypothesis 3, which states that there is a significant sector effect on the working capital measures employed by South African listed industrial firms, is accepted for six<sup>52</sup> of the 13 variables.

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51 These measures are LMR11 (the log of the mean of accounts payable turnover), LMR12 (the log of the mean of long-term loan capital divided by net working capital), LMR13 (the log of the mean of accounts receivable divided by accounts payable), LMR14 (the log of the mean of total current liabilities divided by funds flow), MR15 (the mean of the cash conversion cycle), MR18 (the mean of the net trade cycle), LMR6 (the log of the mean of the current ratio) and LMR7 (the log of the mean of the quick ratio).

52 These measures are LMR9 (the log of the mean of inventory turnover), LMR10 (the log of the mean of accounts receivable turnover), LMR11 (the log of the mean of accounts payable turnover), LMR13 (the log of the mean of accounts receivable divided by accounts payable), MR15 (the mean of the cash conversion cycle) and MR18 (the mean of the net trade cycle).

## CHAPTER 7

## SUMMARY AND CONCLUSIONS

## 7.1 INTRODUCTION

The initiation of and the motivation for this research are based on the following considerations: the importance of working capital management to the financial manager, the paucity of local research in this area of financial management and the substantial value of working capital holdings in South African industrial firms<sup>1</sup>.

The objective of this study was to investigate the association between working capital measures and the returns of South African industrial firms. In pursuit of the research objective and goals, an exhaustive literature study of working capital management was undertaken, followed by empirical research, which employed balance sheet data on South African industrial firms obtained from the Bureau of Financial Analysis.

The purpose of this chapter is fourfold, namely to present:

- \* a review of the research undertaken
- \* a synthesis of the research results and findings
- \* recommendations based on the findings
- \* suggestions for future research

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1 These considerations were discussed in sections 1.2 and 1.3.

## 7.2 REVIEW OF THE RESEARCH UNDERTAKEN

Three research hypotheses were formulated. These hypotheses are as follows:

- (1) The traditional and alternative working capital measures of South African listed industrial firms associate differently with their returns.
- (2) There is a significant size effect on the working capital measures employed by South African listed industrial firms.
- (3) There is a significant sector effect on the working capital measures employed by South African listed industrial firms.

Several goals were derived in chapter 1 from the hypotheses of the study, with the subsequent chapters in the study (chs 2-6) addressing the different goals.

The first goal of the study, namely to provide a theoretical overview of working capital management, was advanced in chapter 2, commencing with a short historical perspective. Thereafter, the study focused on the clarification of definitions and terminology, working capital policy and the need for working capital.

The second goal was addressed in chapter 3, where the components of working capital, namely, cash, accounts receivable, inventories and short-term financing, were essayed in terms of the literature. This was done by briefly discussing the goals, nature and recognised management techniques of each component. Further, support was advocated for the adoption of an integrated approach to the management decisions regarding the different components of working capital.

Goal 3, encompassing the identification of traditional and alternative working capital measures of liquidity, and recognised measures of return, was achieved in chapter 4. Traditional working capital measures were identified according to whether they measure working capital position, working capital activity or leverage. The alternative working capital measures identified in the literature study were the cash conversion cycle, the weighted cash conversion cycle, the comprehensive liquidity index, the net liquid balance, the net trade cycle and Emery's Lambda. Finally, measures of return were scrutinised in

terms of their estimation of the firm's earnings with respect to a given level of sales, a certain level of assets and the owners' investment.

The fourth goal of the study was to describe the methodology used to investigate the association between traditional and alternative working capital measures of liquidity and firm returns. This goal was addressed in chapter 5, the first of the empirical chapters. Financial statement data on South African industrial firms listed on the JSE for the period 1984 to 1993 were obtained from the University of Pretoria's Bureau of Financial Analysis. Exploratory data analysis was undertaken on a derived data set consisting of 135 firms, with 25 variables per firm for each year. The mean per firm (MR) of each variable for the 10 years of data was chosen as the most representative measure for the study. The distributional properties of the variables were such that some variables required logarithmic transformation, thereby improving positively skewed, non-normal data. This was done so that subsequent parametric data confirmation tests could be performed with confidence.

Goals 5 and 6, namely to test the three hypotheses of the study by employing appropriate statistical techniques, and to describe the results and findings of the research, were addressed in chapter 6. Here the research hypotheses were tested, and the results and findings enumerated upon. These results and findings are now synthesised.

### 7.3 SYNTHESIS OF RESULTS AND FINDINGS

The results and findings are synthesised in the order of the three hypotheses of the study.

#### 7.3.1 Findings regarding research hypothesis 1

The first hypothesis states that the working capital measures of South African industrial firms associate differently with their returns. This hypothesis was initially substantiated by means of a chi-square test for association. Thereafter, stepwise regression was undertaken, with the objective of quantifying the underlying relationships between the independent variables (traditional and alternative working capital measures) and the dependent variables (firm returns).

The chi-square statistics in the two-way tables of frequencies above and below the median, manifested significant positive and negative associations between the working capital measures and firm returns. These associations were initially considered according to the traditional working capital position, activity and leverage measures<sup>2</sup>. Thereafter, the associations between the alternative working capital measures and returns were discussed<sup>3</sup>.

Commencing with the working capital position measures, chi-square statistics indicated a positive association between the current ratio and two of the dependent measures, the operating income margin and the operating return on assets. The quick ratio indicated positive association with the operating income margin. Finance theory states that lower liquidity, reflected in lower current and quick ratios, should be accompanied by higher returns, and therefore the expected association would be an inverse one. Nevertheless, these findings are in agreement with previous research undertaken by Kamath (1989:28)<sup>4</sup>.

The chi-square statistics for the first of the working capital activity ratios, inventory turnover, showed significant positive association with return on investment. This indicates that the higher the inventory turnover, the greater the return on investment, in agreement with the theory. Accounts receivable turnover also exhibited significant positive association with three of the return measures - that is - operating return on assets, return on investment and return on equity and negative association with only one return measure, the operating income margin. In divergence from normative supposition, accounts payable turnover exhibited significant positive association with operating return on assets and return on investment; and turnover divided by net working capital manifested negative association with the operating income margin and the net income

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- 2 The working capital position measures identified in the literature study were the current and quick ratios. The activity measures were inventory turnover, accounts receivable turnover, accounts payable turnover and sales to net working capital. The leverage measures were long-term loan capital divided by net working capital, accounts receivable divided by accounts payable and total current liabilities divided by gross funds flow.
  - 3 The alternative working capital measures tested were the cash conversion cycle, the comprehensive liquidity index, the net trade cycle and net liquid balance divided by total assets.
  - 4 Kamath also found that these ratios did not exhibit the anticipated inverse association with operating profit.

margin.

The occurrence of associations in contradiction to theoretical conjecture demonstrates that some of the variables in the data set did not perform as anticipated. A possible explanation for this could be the one-on-one comparison made in the chi-square method, whereas there are probably other factors or variables that affect the associations<sup>5</sup>, not revealed in the chi-square tests.

The working capital leverage measures extensively displayed the greatest associations with the return measures. Long-term loan capital divided by net working capital indicated significant negative association with operating return on assets and return on investment, in accordance with the teaching that a lower ratio, indicating greater use of short-term funding to long-term funding, is preferable. Accounts receivable divided by accounts payable displayed positive association with the operating income margin, and the expected negative association with return on equity. Total current liabilities divided by funds flow registered by far the greatest associations - all negative - with all of the return measures. The lower this leverage measure, the more prodigious the ability of the firm would be to repay short-term funds, and hence the expectation would be, the more inordinate the returns.

In contrast, the alternative working capital measures demonstrated sporadic significant chi-square values. The cash conversion cycle and net trade cycle both manifested significant positive association with the operating income margin, with the cash conversion cycle displaying the anticipated negative association with return on equity. Net liquid balance divided by total assets had significant chi-square statistics, disclosing the expected positive association, with the net income margin and return on investment.

Stepwise regressions, undertaken to quantify the underlying structural relationships between the independent and dependent variables, resulted in regression models being constructed for each of the measures of return. These regression models explained the

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5 This was illustrated in the regression results summarised in section 6.2.2.6, which sometimes indicated different relationships between independent and dependent variables than those of the chi-square test.

variance in the return measures in terms of the working capital measures. For the operating income margin, 57,39 percent of the variance can be explained by the regression model, using three traditional and one alternative working capital measure<sup>6</sup>. For the net income margin, 44,90 percent of the variance can be explained by the regression model by using one traditional and one alternative working capital measure<sup>7</sup>. For the operating return on assets, 28,48 percent of the variance can be explained by the regression model by using two traditional and two alternative working capital measures<sup>8</sup>. For return on investment, 58,96 percent of the variance can be explained by the regression model by using five traditional and one alternative working capital measure(s)<sup>9</sup>. For return on equity, a disappointingly low 17,96 percent of the variance can be explained by the regression model by using two traditional and one alternative working capital measure(s)<sup>10</sup>.

The regression models which achieved the highest multiple coefficients of determination were the models for the operating income margin, the net income margin and return on investment. This finding was sustained by the results of a principal component analysis undertaken in the data exploration<sup>11</sup>, which indicated that these three return measures accounted for the maximum variance in the dependent variables. The implications of this for the remaining two return measures, operating return on assets and return on equity, is that there are other variables, not identified in the study, which account for most of the variance in these measures.

Estimating patterns of the regression models were examined using 1994 data. The models for the operating income margin and the net income margin tended to overestimate,

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- 6 These measures are total current liabilities divided by funds flow, accounts payable turnover, long-term loan capital divided by net working capital and the net trade cycle.
  - 7 These measures are total current liabilities divided by funds flow and the net liquid balance divided by total assets.
  - 8 These measures are total current liabilities divided by funds flow, long-term loan capital divided by net working capital, the net liquid balance divided by total assets and the cash conversion cycle.
  - 9 These measures are total current liabilities divided by funds flow, long-term loan capital divided by net working capital, inventory turnover, turnover divided by net working capital, accounts receivable divided by accounts payable, and the comprehensive liquidity index.
  - 10 These measures are total current liabilities divided by funds flow, long-term loan capital divided by net working capital and the cash conversion cycle.
  - 11 Section 6.2.2.6 advances further comment on this.

whereas the models for operating return on assets, return on investment and return on equity exhibited more precision in estimating return values using 1994 data.

In the synthesis of the chi-square and stepwise regression findings, the following comments are appropriate. The chi-square associations contrary to the theory indicate that the some of the variables in the data set did not perform as expected, with the appropriate relationships between independent and dependent variables not emerging. When comparing these associations reflected by significant chi-square statistics to the results of the regression models, the observation is that the independent variables that behave according to the theory<sup>12</sup> are those that feature the most prominently in the regression models. These are the traditional working capital leverage measures of total current liabilities divided by funds flow, and long-term loan capital divided by net working capital; and the alternative measure of net liquid balance divided by total assets<sup>13</sup>. Further comment will be advanced in section 7.4 on the recommendations of the study.

Based on the findings of the chi-square and stepwise regression techniques, hypothesis 1 of the study was accepted.

### 7.3.2 Findings regarding research hypothesis 2

The second research hypothesis states that there is a significant size effect on the working capital measures employed by South African industrial firms. A t-test was used to test this hypothesis, by evaluating the statistical significance of the disparity between the means of the participating firms. The firms had been classified dichotomously into 'large' and 'small', whether or not they were one of the *Financial Mail's* (1993) top 100 firms when ranked according to total assets.

The results of the t-test indicated that the null hypothesis of no significant differences

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12 By this we mean exhibiting the expected positive or negative association with the return measure.

13 This measure contributed the most to the variance in the dependent variables when stepwise regression was performed using only alternative measures. This contribution was seven percent for the operating income margin, 17 percent for the net income margin, 19 percent for return on investment and nine percent for return on equity.

between the means of the two groups would be accepted for all variables, with the exception of the variable total current liabilities divided by funds flow. A further t-test was performed in an effort to contrast only the largest against the smallest participating firms. This was done by first ranking the participating firms per total assets from highest to lowest, and then comparing the top quartile of firms to the bottom quartile.

The results of this test showed more measures registering t-values where the null hypothesis of no significant differences in the means between the size groups could be rejected. These measures were, at the five percent level of significance, the accounts payable turnover, the three leverage measures of long-term loan capital divided by net working capital, accounts receivable divided by accounts payable and total current liabilities divided by funds flow; and the alternative working capital measures of the cash conversion cycle and the net trade cycle. At the 10 percent level of significance, the null hypothesis of no significant difference in the means between the size groups could be rejected for the current and quick ratios.

This meant that hypothesis 2, regarding working capital measures employed, was accepted, albeit not unconditionally<sup>14</sup>, for eight of the 13 working capital measures. These findings are in general agreement with other research in finance regarding size effect<sup>15</sup>.

### 7.3.3 Findings regarding research hypothesis 3

Hypothesis 3 contends that there is a significant sector effect on the working capital measures employed by South African listed industrial firms. This implies that the working capital measures employed by the participating firms differ across the 16 sectors. Due to the paucity of number of firms per sector, a parametric procedure was not appropriate. Hence, hypothesis 3 was tested by means of the Kruskal-Wallis procedure, the nonparametric equivalent of the t-test for more than two groups, where the actual values

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14 The hypothesis was accepted on the strength of the results of the more stringent size test.  
15 A study by Osteryoung et al (1992:45), for instance, revealed that the current ratio, quick ratio and accounts receivable turnover did not differ across large and small firms. The study did, however, find significant mean differences in the leverage ratios of large and small firms.

of the data are replaced by ranks.

The statistical null hypothesis of no sector effect was rejected for only three measures, namely long-term loan capital divided by net working capital, turnover divided by net working capital and the comprehensive liquidity index. This means that for 77 percent of the working capital measures included in the study, the test results indicated a significant sector effect. These findings are in agreement with other research regarding sector influence<sup>16</sup>, but are questioned on the grounds of lack of control over the effective type 1 error rate.

In the sector test, the 13 independent variables were evaluated in individual ranking procedures, each time using a five percent significance level. When adjusting for an overall five percent level of significance<sup>17</sup>, only six out of the 13 variables exhibited significant p-values. Hence hypothesis 3 of the study regarding significant sector effect was accepted for six out of the 13 variables, that is, for 46 percent of the working capital measures.

#### 7.4 RECOMMENDATIONS

The following recommendations are made, based on the findings of the research.

The results of the regression models for the dependent variables support the notion of the leverage measures, in particular, total current liabilities divided by funds flow, and, to a lesser degree, long-term loan capital divided by net working capital, as indicators of returns<sup>18</sup>. Based on these findings, the following recommendation is made:

\* *It is recommended that financial managers consider the historical values of the leverage measures of total current liabilities divided by funds flow, and long-term*

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16 In this regard, Hawawini et al (1986:23) reported a significant industry effect on a firm's investment in working capital. In a local study, Jordaan et al (1994:71) referred to possible 'sector specific characteristics' in their findings.

17 The method used to adjust for an overall five percent level of significance was considered in section 6.3.

18 Specific reference is made to the return measures of operating income margin, net income margin and return on investment.

*loan capital divided by net working capital, when forecasting firm returns.*

By effecting future projections of these leverage measures, based on historical trends, a decrease in either of these measures should signal an increase in returns, and vice versa.

The findings of the regression tests further point to the net liquid balance as the alternative measure that contributed the most to explanation of the variance in the return measures<sup>19</sup>. The following recommendation is based on this finding:

- \* *It is recommended that financial analysts, lenders and financial managers use the net liquid balance as a relative measure of firm liquidity when attempting to assess the future earnings of an industrial firm.*

Further to this recommendation, financial analysts, lenders and financial managers should bear in mind the lack of variance in returns explained by the well-recognised current and quick ratios, when analysing industrial firms listed on the JSE.

The next recommendation is based on the firm size findings, with particular reference to the working capital measures where differences were found between large and small firms<sup>20</sup>:

- \* *It is recommended that financial analysts, lenders and financial managers, when conducting interfirm comparisons, consider comparing the measures of firms of a similar size, as reflected by their total assets, to allow for the size effect on variables.*

The final recommendation is based on the research findings regarding sector effect, with particular reference to the working capital measures where differences were found

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19 Refer to previous footnote 13 in this chapter.

20 These measures are accounts payable turnover, long-term loan capital divided by net working capital, accounts receivable divided by accounts payable, total current liabilities divided by funds flow, the cash conversion cycle and the net trade cycle, at the five percent level of significance; and the current and quick ratios at the 10 percent level of significance.

between sectors<sup>21</sup>:

- \* *It is recommended that financial analysts, lenders and financial managers, when conducting interfirm comparisons, consider comparing the measures of firms within the same sector, to allow for the sector effect on variables.*

## 7.5 SUGGESTIONS FOR FURTHER STUDY

Research in corporate finance is characterised by the construction of models which are, by their nature, abstractions of reality. In a study of this nature, a myriad of variables might be tested, with many extensions and sophistications possible. Hence new variables and further testing methods could be attempted, where different options might be explored.

One such option would be the examination of the association between market return and working capital measures, providing that the problems with this return measure<sup>22</sup> have been satisfactorily addressed. A second option would be the testing of associations between the alternative working capital measures not tested in this study<sup>23</sup>, that is, the weighted cash conversion cycle and Emery's Lambda and return measures. A third suggestion for future research would be to repeat the association tests for unlisted firms, to see if and how the associations differ. Finally, with sufficient years of data, associations could be investigated using time-series analysis, where temporal trends might be discerned.

## 7.6 CONCLUDING REMARK

The research undertaken in this study of the association between working capital measures and the returns of South African industrial firms has quantified some of the

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21 These variables are inventory turnover, accounts receivable turnover, accounts payable turnover, accounts receivable divided by accounts payable, the cash conversion cycle, and the net trade cycle.

22 The problems are how to adjust for share splits and thin trading without eliminating too many participating firms.

23 This was due to lack of inside information.

underlying structural relationships in this association. Furthermore, the effect of size and sector on the working capital measures employed by South African industrial firms was statistically verified. In this way, the study has provided evidence of empirical confirmation of normative theorems pertaining to working capital management - thereby shedding some light on this sparsely researched domain of financial management in South Africa.

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APPENDIX A  
PYRAMID AND FOREIGN FIRMS EXCLUDED FROM THE DATASET

PYRAMID FIRMS

|           |                                |
|-----------|--------------------------------|
| AF-&-OVER | AFRICAN & OVERSEAS ENTERPRISES |
| A-V-HOLD  | ANGLOVAAL HOLDINGS LTD         |
| A-T-COLL  | ANGLO-TRANSVAAL COLLIERIES LTD |
| BIVEC     | BERZAK ILLMAN INVEST CORP LTD  |
| BERGERS   | BERGERS GROUP LTD              |
| BEVCON    | BEV & CONSUMER IND HLDS LTD    |
| BIDCORP   | BID CORPORATION LTD            |
| CAXTON    | CAXTON LTD                     |
| CONAFEX   | CONSOLIDATED AFEX CORP SOC ANO |
| DALYS     | DALYS LTD                      |
| DELHOLD   | DEL MONTE ROYAL HOLDINGS LTD   |
| EVHOLD    | EVERITE HOLDINGS LTD           |
| FRALEX    | FRALEX LTD                     |
| F-S-I     | FSI CORPORATION LTD            |
| F-S-GROUP | FS GROUP LTD                   |
| FRAME     | FRAME GROUP HOLDINGS LTD       |
| GOLDSTEIN | GOLDSTEIN SM LTD               |
| G5HOLD    | GROUP FIVE HOLDINGS LTD        |
| HUNTCOR   | HUNTCOR LTD                    |
| HISCORE   | HI-SCORE HOLDINGS LTD          |
| INHOLD    | INVESTEC HOLDINGS LTD          |
| IMPERIAL  | IMPERIAL GROUP LTD             |
| JADE      | JAFF-DELSWA INVESTMENTS LTD    |
| KEELEY    | KEELEY GROUP HOLDINGS LTD      |
| LEFIC     | LEWIS FOSCHINI INVESTMENT CO   |
| LIBVEST   | LIBERTY INVESTORS LTD          |
| LENVEST   | LENCO INVESTMENT HOLDINGS LTD  |
| MLNHOLD   | MARLIN HOLDINGS LTD            |
| MCCARTHY  | MCCARTHY GROUP LTD             |
| MOBILE    | MOBILE INDUSTRIES LTD          |
| MARCONS   | MARSHALLS CONTROLLING INV LTD  |
| MASCON    | MASHOLD CONSOLIDATED INV LTD   |
| NEIHOLD   | NEI AFRICA HOLDINGS LTD        |
| OFSIL     | ORANGE FREE STATE INVESTMENTS  |
| PEPGRO    | PEPGRO LTD                     |
| PIKWIK    | PICK N PAY HOLDINGS LTD        |
| PRESHLD   | PRESMED HOLDINGS LTD           |
| PUBHOLD   | PUBLICO HOLDINGS LTD           |
| PERSBEL   | PERSKOR BELEGGINGS BPK         |
| REMBR-BEH | REMBRANDT BEHERENDE BELEG BPK  |
| REVERE    | REVERE RESOURCES SA LTD        |
| RALE      | RALE HOLDINGS LTD              |

|         |                                   |
|---------|-----------------------------------|
| SAKERS  | SAKERS FINANCE & INVESTMENT CORP  |
| S&SHOLD | STOCKS AND STOCKS HOLDINGS LTD    |
| SEARCON | SEARDEL CONSOLIDATED HOLDINGS LTD |
| SPURHLD | SPUR HOLDINGS LTD                 |
| SABVEST | SABVEST LTD                       |
| STORECO | STORECO LTD                       |
| TEGKOR  | TEGNIесе BELEGGINGSKORP BPK       |
| TIB     | TEGNIесе & IND BELEGGINGS BPK     |
| TIHOLD  | TIGER WHEELS HOLDINGS LTD         |
| TRADHLD | TRADEHOLD LTD                     |
| U-CON   | U-CONTROL LTD                     |
| VALCAR  | VAALTRUCAR LTD                    |
| VENTRON | VENTRON CORPORATION LTD           |
| VESTCOR | VESTACOR HOLDINGS LTD             |
| WALHOLD | WALTONS CONS INVESTMENTS LTD      |
| WAICOR  | WAICOR LTD                        |
| WINBEL  | WINBEL LTD                        |
| WESCO   | WESCO INVESTMENTS LTD             |

FOREIGN FIRMS

|           |                                  |
|-----------|----------------------------------|
| AFEX-SA   | AFEX CORPORATION SOCIETE ANONYME |
| BOTREST   | BOTSWANA RST LTD                 |
| CAFCA     | CENTRAL AFRICAN CABLES LTD       |
| CHARTER   | CHARTER CONSOLIDATED P.L.C.      |
| CONAFEX   | CONSOLIDATED AFEX CORP SOC ANO   |
| COPI      | CANADIAN OVERSEAS PACKAGING      |
| FALVEST   | FALCON INVESTMENTS SOC ANONYME   |
| LONFIN    | LONDON FINANCE & INV GROUP PLC   |
| LONRHO    | LONRHO PLC                       |
| LONSUGR   | LONRHO SUGAR CORPORATION LTD     |
| M-C-M     | MHANGURA COPPER MINES            |
| MINORCO   | MINORCO SOCIETE ANONYME          |
| OCEANA    | OCEANA INVESTMENTS CORP. PLC     |
| PORTHLD   | PORTLAND HOLDINGS LTD            |
| RICHEMONT | RICHEMONT SECURITIES LTD         |
| TEX-MILLS | TEXTILE MILLS 1947 HOLDING LTD   |
| TMX       | TELEMETRIX PLC                   |
| TOLUX     | TOLUX SA LTD                     |
| WANKIE    | WANKIE COLLIERY CO LTD           |
| Z-C-I     | ZAMBIA COPPER INVESTMENT LTD     |

APPENDIX B  
NUMBER OF ORIGINAL OBSERVATIONS CAPTURED PER VARIABLE

|     |              |
|-----|--------------|
| R1  | 1350         |
| R2  | 1350         |
| R3  | 1192         |
| R4  | 1350         |
| R5  | 1350         |
| R6  | 1349         |
| R7  | 1349         |
| R8  | 1350         |
| R9  | 1179         |
| R10 | 1193         |
| R11 | 1188         |
| R12 | 1257         |
| R13 | 1347         |
| R14 | 1281         |
| R15 | 1184         |
| R16 | 1181         |
| R17 | 1348         |
| R18 | 1192         |
| R19 | 1188         |
| R20 | 1191         |
| R21 | 1349         |
| R22 | 1346         |
| R23 | 1345         |
| R24 | 1348         |
| R25 | <u>1192</u>  |
|     | <u>31949</u> |

APPENDIX C  
OBSERVATIONS EXCLUDED FROM THE DATASET

| NO. | VARIABLE | IND CODE | FIRM      | YEAR | REASON                          |
|-----|----------|----------|-----------|------|---------------------------------|
| 1   | R6       | 20       | Karos     | 1989 | current liabilities abnormal    |
| 2   | R7       | 20       | Karos     | 1989 | as for 1                        |
| 3   | R6       | 25       | Namfish   | 1990 | as for 1                        |
| 4   | R7       | 25       | Namfish   | 1990 | as for 1                        |
| 5   | R6       | 25       | Namfish   | 1991 | as for 1                        |
| 6   | R7       | 25       | Namfish   | 1991 | as for 1                        |
| 7   | R20      | 26       | Usko      | 1991 | abnormal extraordinary loss     |
| 8   | R22      | 26       | Usko      | 1991 | as for 7                        |
| 9   | R23      | 26       | Usko      | 1991 | as for 7                        |
| 10  | R10      | 25       | Namsea    | 1990 | current assets abnormal         |
| 11  | R13      | 25       | Namsea    | 1990 | as for 10                       |
| 12  | R9       | 25       | Namsea    | 1990 | as for 10                       |
| 13  | R10      | 15       | Bidvest   | 1989 | receivables & payables abnormal |
| 14  | R11      | 15       | Bidvest   | 1989 | as for 13                       |
| 15  | R12      | 15       | Alexander | 1984 | abnormal net current assets     |
| 16  | R12      | 15       | Rentbel   | 1987 | as for 15                       |
| 17  | R12      | 15       | Rentbel   | 1989 | as for 15                       |
| 18  | R15      | 29       | Vektra    | 1984 | turnover unrealistically low    |
| 19  | R18      | 29       | Vektra    | 1984 | as for 18                       |
| 20  | R20      | 28       | Berzack   | 1990 | abnormal extraordinary profit   |
| 21  | R22      | 28       | Berzack   | 1990 | as for 20                       |
| 22  | R23      | 28       | Berzack   | 1990 | as for 20                       |
| 23  | R25      | 37       | Putco     | 1985 | abnormal net current assets     |
| 24  | R25      | 33       | Shoprite  | 1985 | as for 23                       |

APPENDIX D  
UNIVARIATE STATISTICS FOR ALL INDEPENDENT AND DEPENDENT VARIABLES AGGREGATED OVER TIME AND  
SECTOR

| Rx  | OBSERV | SCALE | MEAN   | SD     | MEDIAN | MIN      | MAX     | SKEWNESS | KURTOSIS |
|-----|--------|-------|--------|--------|--------|----------|---------|----------|----------|
| R6  | 1346   | %     | 166,29 | 76,13  | 149,35 | 1,20     | 753,90  | 3,24     | 16,38    |
| R7  | 1346   | %     | 98,60  | 64,86  | 84,80  | 1,20     | 753,90  | 4,63     | 33,24    |
| R9  | 1178   | times | 10,28  | 21,52  | 6,70   | 0,20     | 434,10  | 11,47    | 172,16   |
| R10 | 1191   | times | 11,12  | 38,12  | 5,90   | 0,50     | 676,20  | 12,08    | 165,24   |
| R11 | 1187   | times | 7,31   | 2,95   | 6,90   | -3,50    | 32,70   | 2,30     | 12,03    |
| R12 | 1254   | %     | 87,60  | 213,17 | 36,50  | 0,00     | 3594,00 | 7,95     | 90,01    |
| R13 | 1346   | %     | 138,17 | 149,77 | 109,70 | 0,00     | 2693,50 | 8,71     | 112,14   |
| R14 | 1281   | years | 4,82   | 7,42   | 3,01   | 0,02     | 138,86  | 9,66     | 138,82   |
| R15 | 1183   | days  | 64,40  | 50,52  | 57,70  | -150,30  | 352,70  | 1,37     | 4,65     |
| R16 | 1181   | %     | 136,10 | 65,06  | 129,40 | -48,60   | 1336,80 | 8,22     | 124,32   |
| R18 | 1191   | days  | 65,96  | 51,22  | 58,60  | -178,80  | 354,60  | 1,31     | 4,40     |
| R19 | 1188   | %     | 12,78  | 7,19   | 11,90  | -10,70   | 41,80   | 0,79     | 1,41     |
| R20 | 1189   | %     | 5,59   | 8,98   | 4,90   | -119,90  | 82,60   | -1,57    | 49,05    |
| R21 | 1349   | %     | 19,72  | 9,88   | 19,30  | -11,20   | 71,50   | 0,64     | 2,22     |
| R22 | 1344   | %     | 8,39   | 8,08   | 8,60   | -27,80   | 73,60   | 0,40     | 6,43     |
| R23 | 1343   | %     | 16,32  | 22,46  | 16,80  | -211,00  | 402,10  | 2,66     | 79,87    |
| R24 | 1348   | %     | -0,01  | 0,20   | -0,03  | -1,20    | 1,00    | 0,63     | 5,02     |
| R25 | 1192   | %     | 12,74  | 304,48 | 7,69   | -4790,32 | 8982,00 | 0,40     | 1,64     |

APPENDIX E  
SAS PROGRAM

```

options nocenter formdlim='-';
libname sasdb '.';
proc format;
value aa 15='INDUST HOLDING'
        20='BEV HOTEL &LEISURE'
        21='BLDG, & CONSTR.'
        22='CHEMICALS & OIL'
        23='CLOTHING'
        25='FOOD'
        26='ELECTRONICS'
        27='FURN, & HOUSEHOLD'
        28='ENGINEERING'
        29='MOTOR'
        30='PAPER & PACKAGING'
        31='PHARM & MEDICAL'
        32='PRINT & PUBLISH'
        33='STORES'
        35='STEEL & ALLIED'
        37='TRANSPORTATION';
value bb 1='Yes' 2='No';
value cc 1='<=median' 2='>median';
value dd 1='<=TAq1' 2='>=TAq3';

data work;
set sasdb.meandata;
format jse aa. top100 bb. rr19-rr23 rr6 rr7 rr9-rr14 rr15 rr16 rr18 rr24
        cc. taq1q3 dd.;

label lmr1='LOG CA/TA (%)'
      lmr2='LOG TOTCL/TOTCL + TOTLTLCL (%)'
      lmr3='LOG Turnover (R10 000)'
      lmr4='LOG Profit after taxation (R10 000)'
      lmr5='LOG Total Assets (R10 000)'
      lmr6='LOG Current Ratio (%)'
      lmr7='LOG Quick Ratio'
      lmr8='LOG Net current assets'
      lmr9='LOG Turnover/Total stock (times)'
      lmr10='LOG Turnover/debtors (times)'
      lmr11='LOG (Yend stock + turnover-begstock)/creditors'
      lmr12='LOG TOTLTLCL/net current assets'
      lmr13='LOG Debtors/creditors (%)'
      lmr14='LOG TCL/(Profit after tax + non cash flow items) (%)'
      lmr15='LOG Cash conversion items (days)'
      lmr16='LOG Comprehensive liquidity index (R10 000)'
      lmr17='LOG Net liquid balance (R10 000)'
      lmr18='LOG Net trade cycle'
      lmr19='LOG Trading profit/turnover (%)'

```

```

lmr20='LOG Profit after tax/turnover (%)'
lmr21='LOG Trading profit/total assets (%)'
lmr22='LOG Profit after tax/total assets (%)'
lmr23='LOG Profit after tax/total owners interest (%)'
lmr24='LOG R24'
lmr25='LOG TO/NCA (%)'
top100='Financial mail top 100 co in 1994' ;

```

```

lmr7=mr7 ; lmr9=mr9 ; lmr10=mr10 ; lmr11=mr11 ; lmr12=mr12 ;
lmr6=mr6 ; lmr13=mr13 ; lmr14=mr14 ; lmr16=mr16 ;

```

```

array ll lmr6 lmr7 lmr9-lmr14 lmr16 ;
do over ll ;
  ll=log(ll) ;
end ;

```

```

file 'marolee3.dat' ;
put name 1-10 @12 (lmr6 lmr7 mr8 lmr9-lmr14 mr15 lmr16 mr17-mr25) (11.2) ;

```

```

if mr5 le 9697.1 then taq1q3=1 ;
if mr5 ge 81278.3 then taq1q3=2 ;
if lmr5 gt 9.18 and lmr5 lt 11.31 then delete ;*/

```

```

if mr19 le 11.97 and mr19 ne . then rr19=1 ;
if mr19 gt 11.97 and mr19 ne . then rr19=2 ; if mr19 eq . then rr19=. ;
if mr20 le 4.73 and mr20 ne . then rr20=1 ;
if mr20 gt 4.73 and mr20 ne . then rr20=2 ; if mr20 eq . then rr20=. ;
if mr21 le 19.22 and mr21 ne . then rr21=1 ;
if mr21 gt 19.22 and mr21 ne . then rr21=2 ; if mr21 eq . then rr21=. ;
if mr22 le 8.39 and mr22 ne . then rr22=1 ;
if mr22 gt 8.39 and mr22 ne . then rr22=2 ; if mr22 eq . then rr22=. ;
if mr23 le 16.05 and mr23 ne . then rr23=1 ;
if mr23 gt 16.05 and mr23 ne . then rr23=2 ; if mr23 eq . then rr23=. ;
if lmr6 le 5.02 and lmr6 ne . then rr6=1 ;
if lmr6 gt 5.02 and lmr6 ne . then rr6=2 ; if lmr6 eq . then rr6=. ;
if lmr7 le 4.47 and lmr7 ne . then rr7=1 ;
if lmr7 gt 4.47 and lmr7 ne . then rr7=2 ; if lmr7 eq . then rr7=. ;
if lmr9 le 1.90 and lmr9 ne . then rr9=1 ;
if lmr9 gt 1.90 and lmr9 ne . then rr9=2 ; if lmr9 eq . then rr9=. ;
if lmr10 le 1.76 and lmr10 ne . then rr10=1 ;
if lmr10 gt 1.76 and lmr10 ne . then rr10=2 ; if lmr10 eq . then rr10=. ;
if lmr11 le 1.95 and lmr11 ne . then rr11=1 ;
if lmr11 gt 1.95 and lmr11 ne . then rr11=2 ; if lmr11 eq . then rr11=. ;
if lmr12 le 3.9 and lmr12 ne . then rr12=1 ;
if lmr12 gt 3.9 and lmr12 ne . then rr12=2 ; if lmr12 eq . then rr12=. ;
if lmr13 le 4.72 and lmr13 ne . then rr13=1 ;
if lmr13 gt 4.72 and lmr13 ne . then rr13=2 ; if lmr13 eq . then rr13=. ;
if lmr14 le 1.25 and lmr14 ne . then rr14=1 ;
if lmr14 gt 1.25 and lmr14 ne . then rr14=2 ; if lmr14 eq . then rr14=. ;
if mr25 le 7.88 and mr25 ne . then rr25=1 ;

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if mr25 gt 7.88 and mr25 ne . then rr25=2 ; if mr25 eq . then rr25=. ;
if mr15 le 57.10 and mr15 ne . then rr15=1 ;
if mr15 gt 57.10 and mr15 ne . then rr15=2 ; if mr15 eq . then rr15=. ;
if lmr16 le 4.87 and mr16 ne . then rr16=1 ;
if lmr16 gt 4.87 and mr16 ne . then rr16=2 ; if mr16 eq . then rr16=. ;
if mr18 le 60.30 and mr18 ne . then rr18=1 ;
if mr18 gt 60.30 and mr18 ne . then rr18=2 ; if mr18 eq . then rr18=. ;
if mr24 le -0.01 and mr24 ne . then rr24=1 ;
if mr24 gt -0.01 and mr24 ne . then rr24=2 ; if mr24 eq . then rr24=. ;
proc univariate ;
var mr5 lmr6-lmr7 lmr9-lmr14 mr25 mr15 lmr16 mr18 mr24 mr19-mr23 ;
proc corr ;
var lmr19-lmr23 ;
proc plot hpercent=50 vpercent=50 ;
plot lmr22*(lmr6 lmr7 lmr9-lmr13 lmr14 lmr25 lmr15 lmr16 lmr18 lmr24) ;
proc plot hpercent=50 vpercent=50 ;
plot lmr20*(lmr6 lmr7 lmr9-lmr13 lmr14 lmr25 lmr15 lmr16 lmr18 lmr24) ;
proc plot hpercent=50 vpercent=50 ;
plot lmr19*(lmr6 lmr7 lmr9-lmr13 lmr14 lmr25 lmr15 lmr16 lmr18 lmr24) ;
proc plot hpercent=50 vpercent=50 ;
plot mr22*(mr6 mr7 mr9-mr13 mr14 mr25 mr15 mr16 mr18 mr24) ;
proc plot hpercent=50 vpercent=50 ;
plot mr20*(mr6 mr7 mr9-mr13 mr14 mr25 mr15 mr16 mr18 mr24) ;
proc plot hpercent=50 vpercent=50 ;
plot mr19*(mr6 mr7 mr9-mr13 mr14 mr25 mr15 mr16 mr18 mr24) ;
proc reg data=work ;
model mr23=lmr6 lmr7 lmr9-lmr14 mr25 mr15 lmr16 mr18 mr24 /
method=stepwise ;
output out=result23 p=predic student=sresid ;
proc plot hpercent=50 vpercent=50 data=result23 ;
plot predic*sresid ;
proc reg data=work ;
model mr22=lmr6 lmr7 lmr9-lmr14 mr25 mr15 lmr16 mr18 mr24 /
method=stepwise ;
output out=result22 p=predic student=sresid ;
proc plot hpercent=50 vpercent=50 data=result22 ;
plot predic*sresid ;
proc reg data=work ;
model mr21=lmr6 lmr7 lmr9-lmr14 mr25 mr15 lmr16 mr18 mr24 /
method=stepwise ;
output out=result21 p=predic student=sresid ;
proc plot hpercent=50 vpercent=50 data=result21 ;
plot predic*sresid ;
/* proc print data=result21 ; var name jse ;*/
proc reg data=work ;
model mr20=lmr6 lmr7 lmr9-lmr14 mr25 mr15 lmr16 mr18 mr24 /
method=stepwise ;
output out=result20 p=predic student=sresid ;
proc plot hpercent=50 vpercent=50 data=result20 ;
plot predic*sresid ;

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proc reg data=work ;
  model mr19=lmr6 lmr7 lmr9-lmr14 mr25 mr15 lmr16 mr18 mr24 /
    method=stepwise ;
  output out=result19 p=predic student=sresid ;
  proc plot hpercent=50 vpercent=50 data=result19 ;
  plot predic*sresid ;
/*
proc princomp ;
  var lmr19-lmr23 ;
proc princomp ;
  var lmr6 lmr7 lmr9-lmr14 lmr25 ;
proc princomp ;
  var lmr15 lmr16 lmr18 lmr24 ;
proc freq ;
  tables rr19*(rr6 rr7 rr9-rr14 rr25 rr15 rr16 rr18 rr24) / chisq ;
  tables rr20*(rr6 rr7 rr9-rr14 rr25 rr15 rr16 rr18 rr24) / chisq ;
  tables rr21*(rr6 rr7 rr9-rr14 rr25 rr15 rr16 rr18 rr24) / chisq ;
  tables rr22*(rr6 rr7 rr9-rr14 rr25 rr15 rr16 rr18 rr24) / chisq ;
  tables rr23*(rr6 rr7 rr9-rr14 rr25 rr15 rr16 rr18 rr24) / chisq ;
proc freq ;
  tables jse ;
proc ttest ;
  class taq1q3 ;
  var lmr6 lmr7 lmr9-lmr14 mr25 mr15 lmr16 mr18 mr24 mr19-mr23 ;
proc ttest ;
  class top100 ;
  var lmr6 lmr7 lmr9-lmr14 mr25 mr15 lmr16 mr18 mr24 mr19-mr23 ;
proc freq ;
  tables taq1q3*top100 ;
proc npar1way wilcoxon ;
  class jse ;
  var lmr6 lmr7 lmr9-lmr14 mr25 mr15 lmr16 mr18 mr24 mr19-mr23 ;
proc glm ;
  class jse top100 ;
  model lmr19-lmr23 lmr6 lmr7 lmr9-lmr14 lmr25 lmr15 lmr16 lmr18 lmr24 =
    jse|top100 ;
  means jse|top100 / scheffe lines ;
proc reg data=work ;
  model mr19=lmr6 lmr7 lmr9-lmr14 mr25 /selection=stepwise r ;
  output out=result23 p=predic student=sresid ;
  proc plot hpercent=50 vpercent=50 data=result23 ;
  plot predic*sresid ;
proc reg data=work ;
  model mr19=mr15 lmr16 mr18 mr24 /selection=stepwise r ;
  output out=result21 p=predic student=sresid ;
  proc plot hpercent=50 vpercent=50 data=result21 ;
  plot predic*sresid ;
proc print ;
  var name ;
/*

```