ACTA WASAENSIA

No 21
BUSINESS ADMINISTRATION No 6
ACCOUNTING AND FINANCE

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Address:

Vaasan korkeakoulu
University of Vaasa

Raastuvank. 31
65100 VAASA 10
Finland

ISBN 951-683-246-6
ISSN 0355-2667

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ABSTRACT

Yli-Olli, Paavo & Ilkka Virtanen (1985). Modelling a financial ratio system on the economy-wide level. Acta Wasaensia No 21, 74 p.

The purpose of this study is to develop, on the economy-wide level, an empirically-based classification pattern for commonly used financial ratios and to measure the long-term stability of the ratios. The data used for this study consists of December 31 fiscal year US industrial firms for the period 1947-75. The selected financial ratios are according to a priori classification the measures of short-term solvency, long term-solvency, profitability and efficiency. Classification patterns of the financial ratios are developed via factor analysis and the stability analysis is carried out via transformation analysis.

The empirical results show that empirically-based classifications are not fully equivalent to the a priori classification. The following factors are found: solvency, profitability, efficiency and dynamic liquidity. The empirical results are based both on the value- and equal-weighted indices of the selected ratios. Classification patterns are developed using variables (indices) both in the level and in the first-difference form. The use of the first differences of ratios becomes necessary because of the clear positive or negative trend in the time series. The use of first differences of ratios makes it also possible to overcome the open and quite serious problem concerning the role of constant term in financial ratio analysis. Further, empirical results show that different aggregation methods lead to different results. The theoretically better value-weighted indices (in the first-difference form) give more accurate and interpretative empirical results. Factor patterns based on value-weighted variables in the first difference form display also very clear time series stability. This result confirms the great importance of aggregation method in ratio analysis. Finally, some demonstrations how to use financial ratios in macro-economic analysis are presented.

Paavo Yli-Olli and Ilkka Virtanen, School of Business Studies, University of Vaasa, Raastuvankatu 31, SF-65100 Vaasa, Finland.

KEYWORDS

Financial ratio analysis, classification of financial ratios, stability of financial ratios, aggregation of financial ratios, factor analysis, transformation analysis.

1. INTRODUCTION

1.1. Financial statement analysis

Financial statement analysis is an information-processing system developed to provide relevant data for decision makers. Users of the financial statement analysis are investors, management, lenders, labor unions, regulatory agencies, researchers etc. The great number of information users, their different objectives and different decision-making models have to some extent meant that the ratios used in financial analysis have been numerous and treated as separate figures without explicit theoretical structure (Horrigan 1968: 294). Many alternative categories of financial ratios have been proposed in litterature (Horrigan 1967: Chapter 6, Foster 1978: 24-37, Courtis 1978: 372-375 and Tamari 1978: 24-44). There is no consensus on each ratio as to what the ratio primarily measures because of the differences in standardizing items reported on the financial statements (Aho 1981: 16-19) and because of the differences in computation of financial ratios (Gibson 1982: 13 and Gombola and Ketz 1983: 105). Faced with the great number of potentially useful ratios there has arisen a need to develop some theoretically acceptable system for classifying financial ratios (see e.g. Pinches, Mingo and Caruthers 1973).

Another interesting series of research articles analyses methodological issues in the use of financial ratios. The object of those papers is to provide some insight into assumptions, limitations and uses of accounting ratios (Gonedes 1973, Deakin 1976, Lev and Sunder 1979, Whittington 1980, Barnes 1982, and Frecka and Hopwood 1982).

Further, one important group of researches is formed by the papers which try to measure the predictive power of financial ratios in decision-making (Beaver 1966, Altman 1968, Ball and Brown 1968, O'Connor 1973, Prihti 1975 and Gibson 1982).

1.2. Review of prior research on topic

A great number of individual financial ratios and many of their alternative categories have been proposed in the text-books on accounting (see e.g. Horrigan 1967: Chapter

6, Foster 1978: 24-37, Courtis 1978: 372-375 and Tamari 1978: 24-44, Kettunen-Mäkinen-Neilimo 1979: 29, Aho 1981: 16 and Artto 1982: 27). Such classifications do not, however, always take account of the empirical relationships existing between and among financial ratios. Valuable insight into relationships between financial ratios was first presented by the study of Pinches, Mingo and Caruthers (1973) and by the study of Pinches, Eubank, Mingo and Caruthers (1975). They developed an empirically-based classification system for financial ratios using factor analysis. According to their results the classification patterns of ratios were also reasonably stable over time even when the magnitude of the financial ratios was undergoing change. They analyzed the stability by using correlation coefficients.

Interesting results were recently presented by Combola and Ketz (1983) and Yli-Olli (1983) independently of each other. They showed that profitability ratios and cash-flow ratios do not measure the same characteristic of firm performance (for computation of cash-flow, see Gombola and Ketz 1983: 107). Gombola and Ketz found considerable time series stability of factor patterns. Yli-Olli (1983) and later on Yli-Olli and Virtanen (1984) used so-called transformation analysis (see Yli-Olli and Virtanen 1984: 9-16) to measure the medium-term stability of factor patterns (for the accounting principles of variables see Yli-Olli and Virtanen 1984: 7-8; compare also Aho 1980: 416). Compared with correlation or congruency analysis used in previous studies Yli-Olli and Virtanen got a more clear-cut picture about the stability of factor patterns (and also about the minor unstable elements in these patterns). In this context can also be mentioned an interesting research published by Laitinen (1980). Laitinen advanced a theoretical firm model. He explained with the aid of the model the relationships between the ratios he presented.

Recently it was published a series of research articles concerning methodological issues in the use of financial ratios. It has been very popular to describe the distribution of financial ratios in various countries (Horrigan 1965, Mecimore 1968, O'Connor 1973, Deakin 1976, Bird and McHugh 1977 and Bougen and Drury 1980). The results show that, in general, financial ratios are not normally distributed. Therefore, some transformations are suggested to achieve the normality of the data (see Deakin 1976: 91-96). The usual transformations such as square roots or natural logarithms are often used. However, it is even possible that they merely confuse the data further (see Eisenbeis 1977: 875-899 and Barnes 1982: 57). It is possible to argue that where certain usual statistical multivariate methods, e.g. discriminant analysis or factor analysis are exploratively used in ratio analysis there is no necessity to transform non-normal distributions. On the contrary, the researchers should be very careful in cases with a small number of observations. The study of Copeland and Ingram (1982) shows that the outliers could have a severe impact on the parameter estimates in such a case.

The role of "the constant term" is also considered of great importance by many researchers (Lev and Sunder 1979, Whittington 1980 and Barnes 1982). In this study it is supposed that this serious (and still unsolved) problem can be overcome in some special cases by using the first differences (instead of the original level values) of financial ratios.

During the last two decades, a considerable amount of research has been directed toward analysis of predictive power of financial ratios. Empirical evidence indicates that stock price fluctuations are closely related to changes in accounting earnings (see e.g. Niederhoffer and Regan 1972: 65-71). However, it should be noted that contemporaneous fluctuations between changes in stock prices and earnings do not directly indicate how effectively investors actually use financial data.

Ball and Brown (1968) and O'Connor (1973) conclude that in efficient capital markets the information contained in the annual income numbers is useful in that it is related to stock prices. But annual accounting reports are only one of the many sources of information available to investors. Only 10-15 per cent of the price adjustment took place in the month of income announcement (Ball and Brown 1968: 174-176). Ball and Brown examined the effect of **annual** earnings announcements. It can be supposed that most of the information contained in the annual report has already been published in the quarterly reports. However, the information conveyed by financial statements and ratio analysis could in some cases be more useful to investors than the results of Ball and Brown indicated. In the market where most firms publish only annual reports (e.g. in Finland), annual reports might prove quite useful to investors.

Another group of researches directed toward the predictive power of financial ratios are those concerning the prediction of corporate failure or bankruptcy (see e.g. Beaver 1966, Altman 1968, Meyer and Pifer 1970, Wilcox 1973, Prihti 1975 and

Tamari 1978). Beaver demostrated the predictive power of ratios for individual firm failures using a dichotomous classification test. Altman and Prihti utilized the discriminant analysis and Meyer and Pifer and Tamari regression analysis techniques for predicting corporate bankruptcy. Although many interesting works in this area have been published, only very few researchers have been interested in theoretical aspects of their predictive models (exceptions e.g. Wilcox 1973 and Prihti 1975).

Other important uses of financial statement information consist, for example, of the banks' credit decisions and the prediction of bond risk premiums and ratings. The analysis of the commercial banks' loan offer (supply) function by Hester (1962) was interesting. He tried to find the variables which have the greatest weight on the term loan decisions. Yli-Olli (1980) explained, using simultaneous multi-equation models, investment and financing behaviour of Finnish firms (the loan equation was based on the idea presented by Ruuhela, see Ruuhela 1975: 67-71). In Finland, bank loans are the most important source of the firms' external funds.

1.3. The purpose and progression of the study

The purposes of this research work are:

1. to develop, on the economy-wide level, empirically-based classification patterns for some commonly used financial ratios,

2. to compare, both on the theoretical and empirical levels, the usefulness of different aggregation methods in financial ratio analysis,

3. to measure, using transformation analysis, the long-term stability of financial ratios,

4. to demonstrate the use of financial ratios in macro-economic analysis.

The progress of the text is the following. In this first chapter we took a review of prior research on topic and presented the purposes of the study. In Chapter 2, we will present the financial ratios to be used and analyze also the removal of the trend from time series and the use of first differences of financial ratios in developing an economy-wide empirically-based classification for those ratios.

In Chapter 3, we will present the data and the statistical methods to be used in this study. The main statistical methods are factor and transformation analyses. The properties of different aggregation methods in computing economy-wide indices for financial ratios are also discussed.

In Chapter 4, we will first analyze the macro-economic development of US economy, using value-weighted and equal-weighted indices of financial ratios. Second, we will via factor analysis develop economy-wide financial ratio patterns of financial ratios, using the two different aggregation methods. Thereafter, the analysis will be deepened by using the first differences of the ratios and different rotation methods. After that, we will measure the long-term stability of financial ratios. Based on the results of our study we are able to say which is the best aggregation method and which are, according to empirical criteria, the best financial ratios in our analysis. Finally, we will compare the dependence between the change of stock market prices and the selected financial ratios on an aggregate level.

In Chapter 5, the results of the study are summarized and evaluated.

2. THE SELECTION OF FINANCIAL RATIOS AND SOME BASIC PROPERTIES OF THE RATIOS

In this chapter we present the classification of financial ratios examined. It will also be analyzed what each ratio, a priori, measures. The analysis is based on earlier researches and textbooks.

After selecting the ratios we also discuss one basic problem in ratio analysis, i.e. the role of constant term, and how this problem can be overcome in this study. Other methodological and statistical issues are discussed in Chapter 3.

2.1. The selection of financial ratios

In this study, 12 different ratios are selected, which - **a priori** - measure **short-term solvency** (liquidity ratios), **long-term solvency** (leverage / capital structure ratios), **profitability** (profitability ratios) and **efficiency** (turnover ratios) of the firm (the calculation of these ratios is presented in Appendix 1). This classification is the most common in litterature (see e.g. Lev 1974: 12, Kettunen-Mäkinen-Neilimo 1976: 29, Foster 1978: 28 and Tamari 1978: 24-44) and it is oriented to the needs of users of these ratios (see more about the use of financial ratios Tamari 1978: 71-93 and 146-171).

2.1.1. Liquidity ratios

The ability of a firm to meet its short-term financial obligations is of prime interest to management, merchandise suppliers, lenders and investors. In the extreme case when the firm is not able to meet its short-term financial obligations those groups will be the losers.

The liquidity ratios examined in this study are the **current ratio** (CR), the **quick ratio** (QR) and the **defensive interval measure** (DI) (for calculation of liquidity ratios, see Foster 1978: 43-44). The current and quick ratios are, in principle, very similar. The denominator of both ratios consists of current liabilities. The numerator of the current ratio consists of current assets. The quick ratio includes in the numerator cash marketable securities and accounts receivable (current assets - (inventories + other current assets)). According to Lev (Lev 1974: 28) the quick ratio provides a stricter test of liquidity than the current ratio. In Gibson's inquiry (Gibson (1982); a questionnaire was sent to the financial executives of the 500 largest industrial firms for 1979 listed in Fortune) there was a big consensus on each ratio as to what the ratio primarily measures: 94 % of the firms were of such opinion that the current ratio is a measure of liquidity. The corresponding number of quick ratio was 80 %.

The current and quick ratios have been criticized on the basis of their static structure (see Walter 1957: 38). These ratios reflect the surplus of current assets over current liabilities at a point in time.

This criticism led to the development of cash- and funds-flow-based liquidity ratios. Such a ratio is the defensive interval measure (see Davidson, Sorter and Kalle 1964: 23-26). This measure incorporates a dynamic element in liquidity evaluation. According to the results of Davidson's, Sorter's and Kalle's empirical study "there is substantial evidence that the interval measure and the traditional ratios (e.g. current ratio) produce differing impressions of the size and movement of a firm's defensive strength".

2.1.2. Long-term solvency ratios

A firm may finance its activies - as far as the external financing of the firm is concerned - either by using the funds borrowed or by investing the owners' money.

The selected long-term solvency ratios in this study are the **debt-to equity** (DE), **long-term debt to equity** (LTDE) and **times interest earned** (TIE) ratios.

Debt to equity and long-term debt to equity are very similar by nature and they are - like the current and quick ratios in liquidity measurement - static measures of the long-term solvency of the firm. They are measures for financial risk associated with the shareholders' equity.

The times interest earned ratio incorporates a dynamic element in long-term solvency evaluation.

2.1.3. Profitability ratios

It is presented in many textbooks that profitability may reflect different things to different users. Therefore many different indicators of profitability should be considered (see e.g. Tamari 1978: 25). In this study, three different ratios are used: **earnings to sales** (ES), **return on assets** (ROA) and **return on equity** (ROE).

The first ratio (ES) is a surrogate of operational efficiency of the firm and both the numerator and denominator of the ratio represent a flow over the entire period (i.e. a year). The second ratio (ROA) measures how efficiently total assets of the firm are being utilized. The third and most interesting ratio (ROE) indicates the profitability of the capital supplied by common stockholders.

2.1.4. Turnover ratios

Turnover ratios measure different aspects of firm's performance, i.e. the efficiency of the firm in using its assets in order to generate income. The selected turnover ratios are: **total assets turnover** (TAT), **inventory turnover** (IT) and **accounts receivable turnover** (ART).

Total assets turnover together with earnings to sales (the first profitability ratio in this study) comprices the so-called DuPont system of ratio analysis (Foster 1978: 44). The inventory turnover ratio is supposed to indicate the efficiency of inventory management. The problem to be solved by inventory management is to determine and maintain an optimal inventory level. Accounts receivable turnover has been said to indicate efficiency of the credit department (Lev 1974: 28). So, the diminishing of this ratio may be due either to faulty collection system or to the weak financial position of the debtors. On the other hand, the reason can also be that the firm attempts to increase sales by granting more credit to customers. Irrespective of the cause, the decrease of this ratio from the target level indicates greater risk than the changes of default by customers.

2.2. Some basic properties of financial ratios

In recent years, a series of research articles concerning methodological issues of financial ratios has been published. A major reason for using financial variables in the form of ratios is to control the systematic effect of size on the variables. Thereafter the ratios are compared with some industry norms.

In this study it is accepted that some financial industry norms may be important in decision making. In our opinion, however, it should first be determined if those norms are ratios. If they are, one must decide what are the potentially good ratios and select among them those ratios which measure the same characteristic of the firm's performance during different cyclical conditions. The next task is then to solve the aggregation problem of ratios. Only after that it becomes possible to give some predetermined standards to firms.

In the empirical part of this research, where 12 financial ratios are analyzed during a 25-years period, it is possible to see a very clear positive or negative trend in each time series (see Chapter 4.1.). At the same time, the time series include considerable cyclical fluctuations. These features mean that strong seeming correlations exist between the ratios and also autocorrelation is included in the time series of the ratios. Both of these phenomena may cause difficulties in the subsequent analyses.

One commonly used way to get rid of these harmful elements in the data is to use the first differences of the variables (instead of their original level values). In this study -because we are mainly interested in long-term behaviour of the ratios and relationships between them but not in their industry norms (i.e. the absolute level of their values) - it is also possible to use this technique. In addition, the use of the first order differences makes it possible, at least to some extent, to overcome the difficult problem of existence (or non-existence) of the constant term in computing the ratios. The last point of view is discussed in what follows.

The usual method of defining a financial ratio is to specify it without the constant term (see e.g. McDonald and Morris 1984: 90), i.e. is the form

$$(2.1) \qquad r_{ti} = a_{ti}/b_{ti}, \qquad t = 1,2,\ldots, T; \; i = 1,2,\ldots, N,$$

where r_{ti} denotes the financial ratio in question for the ith firm in year t, and a_{ti} and b_{ti} are the relevant firm-specific accounting numbers in year t. Industry-or economy-wide indices of the ratio can be taken into account for the firm-specific value of the ratio when we write

$$(2.2) \qquad r_{it} = r_t + \varepsilon^*_{ti}, \qquad t = 1,2,\ldots, T; \; i = 1,2,\ldots, N,$$

where the component r_t is common to all the firms and ε^*_{ti} is the individual component of the ith firm's ratio. In the following, normal assumptions of ordinary least squares concerning the stochastic properties of the "error term" ε^*_{ti} are supposed. Combining equations (2.1) and (2.2) we can write

$$(2.3) \qquad a_{ti}/b_{ti} = r_t + \varepsilon^*_{ti}, \qquad t = 1,2,\ldots, T; \; i = 1,2,\ldots, N$$

and further

$$(2.4) \qquad a_{ti} = r_t b_{ti} + \varepsilon_{ti}, \qquad t = 1,2,\ldots, T; \; i = 1,2,\ldots, N,$$

where $\varepsilon_{ti} = b_{ti}\,\varepsilon^*_{ti}$. The assumption about zero mean value for ε_{ti} still holds but the assumptions of homoscedasticity or independence do not hold.

An alternative definition for r_t, including a constant term in it, can be given in the following modified form:

$$(2.5) \qquad a_{ti} = a_{oi} + r'_t b_{ti} + \varepsilon'_{ti}, \qquad t = 1,2,\ldots, T; \; i = 1,2,\ldots, N.$$

Using equations (2.4) and (2.5) it is possible to obtain indices without and with the constant term, respectively, concerning the whole population. By taking the expectations over the firms, we obtain first from equation (2.4)

$$(2.6) \qquad E(a_{ti}) = r_t E(b_{ti}) + E(\varepsilon_{ti}), \qquad t = 1,2,\ldots, T,$$

which, by taking into account the assumption $E(\varepsilon_{ti}) = 0$ and by denoting $E(a_{ti}) = a_t$,

$E(a_{oi}) = a_o$ and $E(b_{ti}) = b_t$, becomes

(2.7) $$a_t = r_t b_t, \qquad t = 1,2,\ldots, T.$$

On similar lines, from (2.5) we can obtain

(2.8) $$a_t = a_o + r'_t b_t, \qquad t = 1,2,\ldots, T.$$

Comparing (2.7) and (2.8), we can see that different values for the economy-wide index (for the aggregated financial "ratio") are obtained depending whether the constant term is included or not in the definition. The following derivation shows that the two approaches differ less when the first differences of the ratios are used instead of the level values.

For the first differences of r_t and r'_t (for Δr_t and $\Delta r'_t$, respectively) we obtain

(2.9) $$\Delta r_t = r_{t+1} - r_t = \frac{a_{t+1}}{b_{t+1}} - \frac{a_t}{b_t} = \frac{a_{t+1} b_t - a_t b_{t+1}}{b_t b_{t+1}}$$

and

(2.10) $$\Delta r'_t = r'_{t+1} - r'_t = \frac{a_{t+1} - a_o}{b_{t+1}} - \frac{a_t - a_o}{b_t}$$

$$= \frac{a_{t+1} b_t - a_t b_{t+1}}{b_t b_{t+1}} + \frac{a_o(b_{t+1} - b_t)}{b_t b_{t+1}}$$

$$= \Delta r_t + \frac{a_o(b_{t+1} - b_t)}{b_t b_{t+1}} .$$

On the basis of the empirical data used in this study (aggregated ratios) it is not possible to conclude numerically the exact absolute or relative magnitude of the difference between $\Delta r'_t$ and Δr:

(2.11) $$\Delta r'_t - \Delta r_t = \frac{a_o(b_{t+1} - b_t)}{b_t b_{t+1}} = \frac{a_o}{b_{t+1}} \frac{\Delta b_t}{b_t} .$$

However, it is possible to conclude that in most cases the difference between $\Delta r'_t$ and Δr_t is relatively smaller than that between r'_t and r_t. The difference between $\Delta r'_t$ and Δr_t is the difference of the denominator of the original accounting number to be examined ($= \Delta b_t$) multiplied by the term $a_o/b_t b_{t+1}$. In most cases this term is very small. The reason is that the major objective of variable b_t is to control the systematic effect of size on the examined variables and therefore it is quite large and stable over time. Therefore, both of the factors in the numerator of (2.11) are very small compared with the factors in the denominator. So must also the difference $\Delta r'_t - \Delta r_t$ be small. In the special case where the size or value variable b_t remains constant, i.e. $\Delta b_t = 0$, the differences Δr_t and $\Delta r'_t$ even coincide. This holds although the ratios r_t and r'_t themselves differ.

All together, the use of the first differences in the analysis makes it to some extend possible to overcome the open problem concerning the inclusion of the constant term into the financial ratios. The analysis presented above is in a way analogical to the usual econometric technique where the constant term is suppressed by using the first differences in variables. The regression coefficient remains the same as in the original formulation (with level values in variables) but the disturbance term is different.

3. DATA AND STATISTICAL METHODS

In this chapter, we present the data and give a brief description of the statistical methods used the study. We also discuss the different aggregation methods to produce economy-wide data.

3.1. Data and empirical variables

The firms used for this report are selected from an Annual Industrial COMPUSTAT tape containing data for all December 31 fiscal year US firms for the period 1947-75 (see Foster 1978: 156-160). The number of firms in the sample varies from year to year, increasing from about 450 in 1947 to about 1500 in 1975. The use of the same fiscal year firms gives a more clear-cut picture about different phases of economic cycles than the use of all firms regardles of the fiscal year. This is especially important in such cases - as in this study - where the analysis is mainly based on the first differences of the variables. The uniform timing of data is also important in Chapter 4 where we demonstrate the use of financial ratios in macro-economic analysis.

The observations (rows) in the data metrix consist of the years 1947-1975 (denoted by $t = 1,2,..., T$, respectively). The variables are the average values of the selected 12 financial ratios, the average values being computed across the individual firms. The average values have been computed in two different ways, as arithmetic averages and as weighted averages. In the following, some definitional properties of these two ways to aggregate the individual firm-specific ratios into an economy-wide index are presented and compared to each other.

The ratios to be considered are defined in the traditional form, i.e. without the constant term (cf. the discussion in Section 2.2). For firm i in year t we thus have

$$(3.1) \qquad r_{ti} = a_{ti}/b_{ti}, \qquad t = 1,2,..., T; \; i = 1,2,..., N_t.$$

The usual arithmetic mean across the individual firms in year t is simply

$$(3.2) \qquad \bar{r}_t = (1/N_t) \sum_{i=1}^{N_t} (a_{ti}/b_{ti}), \qquad t = 1,2,..., T.$$

The general form of the weighted average is

$$(3.3) \qquad \bar{r}_t^w = \sum_{i=1}^{N_t} w_{ti} r_{ti}, \qquad t = 1,2,..., T,$$

where the weights w_{ti}, $t = 1,2,..., T$, $i = 1,2,..., N_t$, satisfy the conditions

$$(3.4) \qquad 0 \leq w_{ti} \leq 1, \qquad \sum_{i=1}^{N_t} w_{ti} = 1.$$

In computing the weighted average (3.3), it is usual that the individual firm-specific ratios are weighted according to the size of the firms during the year in question. As the denominator of any financial ratio is typically a size or value variable (sales, equity etc.), the usual way to proceed is to use weights which are proportional to the denominators of the ratio. We thus have

$$(3.5) \qquad \bar{r}_t^w = \sum_{i=1}^{N_t} w_{ti} r_{ti}$$

$$= \sum_{i=1}^{N_t} (b_{ti} / \sum_{i=1}^{N_t} b_{ti}) r_{ti}$$

$$= \sum_{i=1}^{N_t} (b_{ti} / \sum_{i=1}^{N_t} b_{ti}) (a_{ti}/b_{ti})$$

$$= (\sum_{i=1}^{N_t} a_{ti}) / (\sum_{i=1}^{N_t} b_{ti}), \qquad t = 1,2,..., T.$$

The last equation in (3.5) shows that the weighted average of the firm-specific values of a financial ratio, the weights being proportional to the size of the firms, can also be expressed as the ratio of the sums (over the individual firms) of the accounting numbers appearing in the numerator and in the denominator of the ratio, respectively.

Both the arithmetic mean (3.2) and the weighted average (3.5) are usual mathematical tools in aggregating individual firm-specific values into an industry- or economy-wide index. On the basis of equation (3.5) one can, however, see that the use of the weighted average preserves for the aggregated index certain important definitional properties of the original ratio. The same is not true when the arithmetic mean is used.

First, the ratio for a specific firm i in year t (equation (3.1)) and the aggregated index in the same year (equation (3.5)) are analogical by definition. They are ratios of the total amounts of quantity a and quantity b observed in year t in firm i and in the whole group, respectively. The arithmetic mean (3.2) has no corresponding definitional interpretation.

Second, the so-called DuPont system of ratios is well-known in the ratio litterature (cf. Section 2.1.4.). In general terms, the DuPont system consists of three ratios, two of which are formed by definition and the third is a derived ratio. Let the two original ratios (i.e. earnings to sales and total assets turnover) be denoted as

$$(3.6) \qquad r_{1ti} = a_{ti}/b_{ti}, \qquad t = 1,2,\ldots, T$$

and

$$(3.7) \qquad r_{2ti} = b_{ti}/c_{ti}, \qquad t = 1,2,\ldots, T .$$

The third, derived, ratio in the DuPont system (i.e. earnings to average total assets) is then

$$(3.8) \qquad r_{3ti} = r_{1ti} \cdot r_{2ti} = a_{ti}/c_{ti}, \qquad t = 1,2,\ldots, T .$$

Using weighted averages in computing the corresponding aggregated indices, we obtain

$$(3.9) \qquad \bar{r}^w_{1t} = (\sum_{i=1}^{N_t} a_{ti}) / (\sum_{i=1}^{N_t} b_{ti}), \qquad t = 1,2,\ldots, T ,$$

$$(3.10) \qquad \bar{r}^w_{2t} = (\sum_{i=1}^{N_t} b_{ti}) / (\sum_{i=1}^{N_t} c_{ti}), \qquad t = 1,2,\ldots, T ,$$

$$(3.11) \qquad \bar{r}^w_{3t} = (\sum_{i=1}^{N_t} a_{ti}) / (\sum_{i=1}^{N_t} c_{ti}), \qquad t = 1,2,\ldots, T .$$

On the other hand, by multiplicating $\bar{r}^w_{1t}$ and $\bar{r}^w_{2t}$, we obtain

$$(3.12) \qquad \bar{r}^w_{1t} \cdot \bar{r}^w_{2t} = (\sum_{i=1}^{N_t} a_{ti}) / (\sum_{i=1}^{N_t} c_{ti}) = \bar{r}^w_{3t}, \qquad t = 1,2,\ldots, T ,$$

i.e. the use of weighted averages preserves the properties of the DuPont system (3.6) - (3.8) also in the aggregated level. The same is not true, when arithmetic means are used.

Above we have discussed two different weighting schemes in producing economy-wide indices for the ratios (also the arithmetic mean (3.2) can be considered as a weighted average, the weights (3.4) must only be the same, i.e. each w_{ti} equals $1/N_t$). One can theoretically reason, on the basis of properties (3.5) and (3.12), for example, that the technique of weighted averages preserves better the properties of the ratio in the aggregation procedure. There are also empirical reasons why weighted averages might be superior to arithmetic means in aggregating ratios. It is typical that extreme values appear in computing ratios. This happens, for instance, when the denominator of a firm's ratio is close to zero. In most cases, the weighted average appears to be less affected by such firm-specific extreme values than the arithmetic mean does.

The definition and computation of the variables in the data matrix is presented in Appendix 1. The numerical values of the variables are presented in Appendix 2. These aggregated indices are given both as arithmetic means (called equal-weighted averages, see the discussion above) and as value-weighted averages (equation (3.5)). As a consequence, we have two different data matrices for our analysis.

3.2. Statistical methods

The empirical analysis in the study is based on multivariate time series data. The main statistical methods to be used are, therefore, typical methods of multivariate statistical analysis: factor analysis and transformation analysis. Factor analysis can be regarded as a usual technique in business applications. Transformation analysis, on the contrary, has been largerly applied only in Finnish political and sosiological research. Therefore, the paper contains a short description of the main features of this multivariate method. And as transformation analysis uses the results of previous factor analyses, also a brief description (e.g. the notation) of this technique, in spite of its popularity, will be presented.

3.2.1. Factor analysis

One of the specific purposes of the study is to develop from a set of 12 financial ratios (of the economy-wide averages of these ratios in fact) classification patterns for the ratios in a lower dimension than the measurements in the data matrix have been presented. This is a typical problem to be handled via multivariate factor analysis.

The essential purpose of factor analysis is (Johnson and Wichern 1982: 401) to describe the covariance (or correlation) relationships among many variables in terms of a few underlying, but unobservable random quantities called factors. The factor model may be motivated by the following argument. Suppose variables can be classified by their correlations. That is, all variables within a particular class are highly correlated among themselves but have relatively small correlations with variables in a different class. It is conceivable that each class of variables represents a single underlying construct or latent variable, factor, that is responsible for the observed correlations. For example, high correlations among the ratios earnings to sales (ES), return on assets (ROA) and return on equity (ROE), and small correlations between these and the other variables might suggest an underlying "profitability" factor.

The aim of factor analysis thus is to reduce the space of correlated variables into a

factor space of lower dimensionality. This reduction is done in such a way as to retain as much of the original information (the total variance of the original variables) as possible.

Let us assume that we have p original variables $x_1, x_2, ..., x_p$ with mean values $\mu_1, \mu_2, ..., \mu_p$ and variances $\sigma_1^2, \sigma_2^2, ..., \sigma_p^2$, respectively. The common factor model postulates, that each x_i is linearly dependent upon a few unobservable variables $f_1, f_2, ..., f_r$ $(r < p)$, called common factors, and an additional source of variation u_i, called specific factor. The factor analysis model thus is (see e.g. Johnson and Wichern 1982: 402-407)

$$x_i - \mu_i = l_{i1}f_1 + l_{i2}f_2 + ... + l_{ir}f_r + u_i, \quad i = 1,2,...,p \tag{3.13}$$

or, in matrix notation

$$\mathbf{x} - \mu = \mathbf{Lf} + \mathbf{u}, \tag{3.14}$$

where $\mathbf{x}' = (x_1, x_2, ..., x_p)$, $\mu' = (\mu_1, \mu_2, ..., \mu_p)$, $\mathbf{L} = (l_{ij})_{pxr}$, $\mathbf{f}' = (f_1, f_2, ..., f_r)$ and $\mathbf{u}' = (u_1, u_2, ..., u_p)$. The coefficient l_{ij} is called the loading of the ith variable on the jth factor, so the matrix $\mathbf{L}$ is the matrix of factor loadings. Note that the ith specific factor u_i is associated only with the ith response x_i (u_i includes measurement error and quantities that are uniquely associated with the ith individual variable x_i). The p deviations $x_i - \mu_i$, $i = 1,2,..,p$, are expressed in terms of $r + p$ random variables $f_1, f_2, ..., f_r$, $u_1, u_2, ..., u_p$, all of which are unobservable. This distinguishes the factor model from the usual multivariate regression model in which the independent variables (whose position is now occupied by the f_i's) can be observed.

Factor analysis contains three main phases: factoring, rotation and interpretation. The first phase, factoring, means the estimation of the factor matrix $\mathbf{L}$, i.e. estimation of the number of factors r and the loadings l_{ij}. With so many unobservable quantities, a direct estimation of the factor model from the observations is hopeless. However, with some additional assumptions about the random vectors $\mathbf{f}$ and $\mathbf{u}$, the model (3.14) implies certain covariance relationships, which can be checked, see e.g. Johnson and Wichern (1982: 403-404). One output of these assumptions is that in the case of orthogonal (uncorrelated) factors the variance of the ith variable x_i can be expressed in the form

(3.15) $$var(x_i) = h_i^2 + \psi_i ,$$

where

(3.16) $$h_i^2 = l_{i1}^2 + l_{i2}^2 + ... + l_{ir}^2$$

is the ith communality, that portion of $var(x_i)$ explained by the r common factors, and ψ_i is the portion of $var(x_i)$ due to the specific factor (the "unexplained" variance). Further we have

(3.17) $$cov(x_i,f_j) = l_{ij} ,$$

i.e. the loadings l_{ij} give the covariance structure between the variables and factors. In the case of standardized variables, instead of the deviations about the mean used in (3.13), the covariance structure becomes even more simple: the communality and the specific variance in (3.15) add to unity and the loadings l_{ij} give correlation coefficients between the variables and the factors (i.e. all these measures are scaled between 0 and 1 in absolute values).

If the factors f_j are allowed to be correlated, we have the oblique factor model. The oblique model presents some additional estimation difficulties which will not be discussed here. For the oblique factor model see Harman (1967: ch. 13 and ch. 15).

The main estimation methods in the phase of initial factor extraction are principal component method, principal factor method and maximum likelihood method (see e.g. Johnson and Wichern 1982: 407-420). In this study the initial factor matrix is estimated by the principal component method. In estimating the dimension of the factor space there exists no unambiguous criterion. Several procedures for determining how many common factors to extract have been suggested. In this study the number of factors is in the first hand determined according to the a priori hypothesis on the existence of four different classes of ratios (i.e. four factors). This criterion will be replenished by interpretative aspects and by eigenvalue and Cattell's scree test criteria.

There is always some inherent ambiquity associated with the factor model (3.14). For, if we have a nonsingular $r \times r$ matrix T, and we denote

(3.18) $$L^* = LT \quad \text{and} \quad f^* = T^{-1} f ,$$

we can write

(3.19) $$\begin{aligned} x - \mu &= Lf + u \\ &= LTT^{-1} f + u \\ &= L^* f^* + u . \end{aligned}$$

From (3.19) we can see that factor loadings L (and factors f) are determined only up to a nonsingular matrix T. Equations (3.18) represent the rotation phase of factor analysis. The initial loading matrix is rotated (multiplied by a nonsingular matrix), where the rotation is determined by some "simple-structure" or "ease-of-interpretation" criterion. The aim of the rotation thus is to provide a clearer resolution of the underlying factors.

If matrix T is orthogonal (i.e. $T^{-1} = T'$) we have an orthogonal rotation. In this case the loadings L and $L^* = LT$ both give the same covariance representation for the original data. The communalities, given by the diagonal elements of $LL' = (L^*)(L^*)'$, are also unaffected by the choice of T. The results in this study are mainly based on Kaiser's Varimax rotation which is an orthogonal rotation method. Some additional or interpretatively supporting results are obtained via Quartimin rotation. This is a nonorthogonal (an oblique) rotation where the resulting factors are allowed to be correlated.

Factor analysis contains several elements which have no unique solution (how many factors to extract?, how to choose the rotation matrix T?, etc.). In applications it is therefore important that these ambiguous quantities are fixed as to produce results which are based on some relevant theory and have meaningful empirical interpretations. Generally speaking, the interpretative phase is a proper part of the entire factoring process.

3.2.2. Transformation analysis

Another specific purpose of this study is to measure and model the long-term stability in the factor analytical classification patterns. The degree of stability (both time-series and cross-sectional) in factor patterns has been traditionally measured with correlation coefficients (e.g. Pinches, Mingo and Caruthers 1973, Aho 1980) or with congruency coefficients (e.g. Johnson 1978, Gombola and Ketz 1983). Both of these measures give an index for the similarity of two different factor solutions in terms of the pattern of correlations among factor loadings across all variables in the reduced factor space. For the dissimilar part of these factor solutions these indices are, however, unable to describe and explain the reason for the non-invariant part prevailing in these factor solutions.

Recently, Yli-Olli (1983) introduced the use of transformation analysis for determining the degree and nature of medium-term stability exhibited by the factor patterns of the financial ratios. This approach was further applied and deepened by Yli-Olli and Virtanen (1984).

Transformation analysis was initiated by Ahmavaara (1954) and further developed by Ahmavaara (1963 and 1966), Ahmavaara and Nordenstreng (1970) and Mustonen (1966). The most applications of transformation analysis exist in the area of Finnish political and sociological research (e.g. Markkanen 1964, Nordenstreng 1968). Originally transformation analysis was developed to compare factor solutions between two (or more) different groups of objects, Yli-Olli (1983) and Yli-Olli and Virtanen (1984) have used the technique to compare two different factor solutions among the same group of objects, the two factor solutions being based on measurements made at different times (at two different time periods). The latter use of transformation analysis means its use for measuring and modelling the medium-term stability of the financial factor patterns. In the following we sketch out the general idea behind transformation analysis (for a more detailed discussion, see e.g. Ahmavaara 1966, Mustonen 1966).

Let's assume that we have two groups of observations G_1 and G_2 (two different groups of objects or one group measured at two different times) with the same variables, both by number and by content. Let L_1 and L_2 be the factor matrices

(cf. equation (3.14)) for G_1 and G_2, respectively. Let's further assume that the factor models used in deriving L_1 and L_2 are both orthogonal and have the same dimension (these assumptions are not, in general, necessary, but transformation analysis which is restricted to orthogonal factor solutions with the same number of factors is computationally simpler and interpretatively more clear-cut). So we may assume that both L_1 and L_2 are pxr-matrices.

If there exists invariance between the two factor structures, there exists a non-singular rxr-matrix T_{12} such that equation

$$L_2 = L_1 T_{12} \tag{3.20}$$

holds. Matrix T_{12} is called the transformation matrix (between L_1 and L_2, or in direction $G_1 \rightarrow G_2$). If equation (3.20) holds exactly, it means that the factor structures in groups G_1 and G_2 are, up to a linear transformation, invariant, all the variables have the same empirical meaning in different groups. Depending on the type of the transformation matrix T_{12}, the formation of the factors from the variables and thereby the interpretation of the factors either is preserved (T_{12} is the identity matrix I) or it changes (T_{12} has also non-zero off-diagonal elements).

In practice, situation (3.20) will not be reached, but, after matrix T_{12} has been estimated, we have $L_2 \neq L_1 T_{12}$. The goodness of fit criterion for the model (3.20) may be based on the residual matrix

$$E_{12} = L_1 T_{12} - L_2 . \tag{3.21}$$

Non-zero elements in E_{12} mean that the empirical meaning of the variables in question has changed. This is called abnormal transformation.

To avoid confusion it is worth to note here that in the case of two factor solutions L and L^* which have been obtained from the same set of observations, we always have an exact solution T for the equation (3.20). In fact, this is the problem of rotation considered in Section 3.2.1. (cf. equations (3.18) and (3.19)). Now the situation is quite different when two separate sets of observations are considered.

The main problem in transformation analysis is the estimation of the matrix T_{12}. The estimation methods are in general based on the minimization of the sum of squares of the residuals e_{ij} (the elements of the residual matrix E_{12}). This is the usual method of least squares. The problem is to minimize

$$\text{(3.22)} \qquad \| E_{12} \| = \| L_1 T_{12} - L_2 \| = \text{trace}\,((L_1 T_{12} - L_2)(L_1 T_{12} - L_2)') \,.$$

Depending on additional constraints set for the matrix T_{12}, we have three different estimation methods (three transformation analysis models).

1. If there are no constraints for T_{12} in minimizing (3.22) we have the naive model. This is the original solution for the transformation problem presented by Ahmavaara (1954). The naive model has been now superseded by the other models in the applications.

2. If the transformation matrix has to obey the transitivity property $T_{kl}T_{lm} = T_{km}$, we get the relativistic model. The relativistic model has been also developed by Ahmavaara (1963, 1966). The relativistic transformation analysis possesses some general theoretical advantages, wherefore it is prefered by some authors (Ahmavaara 1966, Ahmavaara and Nordenstreng 1970, Markkanen 1964, Nordenstreng 1968).

3. If the transformation matrix T_{12} is required to be orthogonal, i.e. $T_{12}^{-1} = T'_{12}$, we have the symmetric model. In this case we obtain the following symmetry property: $E_{12}E'_{12} = E_{21}E'_{21}$, i.e. the covariance matrix of the residuals is independent of the direction of the transformation. The symmetric model was introduced by Mustonen (1966). The results obtained via this method are in general easy to be interpreted wherefore the symmetric version of transformation analysis has been used in most applications. It is worth to note that the problem of estimating T_{12} in (3.20) under the same assumptions as those used in symmetric transformation analysis has been independently solved by Schönemann (1966). Schönemann has considered the problem, however, purely from the point of view of mathematics, without any explicit connections to factor or transformation analysis.

In this study the symmetric transformation analysis will be used. The results have the following properties (Mustonen 1966: 8):

1. Transformation matrices are orthogonal.
2. Abnormal transformation (measured by residuals) is independent of the direction between the groups.
3. Orthogonal rotations in the original factor spaces have no effect on the results.

Further, in symmetric transformation analysis the abnormal transformation (the total residual) $\|E_{12}\|$ may be expressed in form

$$\text{(3.23)} \qquad \| E_{12} \| = \sum_{i=1}^{p} \sum_{j=1}^{r} e_{ij}^2 = \sum_{i=1}^{p} t_i^2$$

or

$$\text{(3.24)} \qquad \| E_{12} \| = \sum_{j=1}^{r} \sum_{i=1}^{p} e_{ij}^2 = \sum_{j=1}^{r} s_j^2$$

where $t_i^2 = \sum_{j=1}^{r} e_{ij}^2$ and $s_j^2 = \sum_{i=1}^{p} e_{ij}^2$ are those portions of abnormal transformation due to the ith variable x_i and jth factor f_j, respectively.

In this study the two groups to be compared via transformation analysis consist of observations made in two successive time periods: years 1947-1961 (sub-period 1) and years 1962-1975 (sub-period 2). Transformation analysis is thus used as a technique to describe and measure the longitudinal stability existing in the observations. Invariance between the factor patterns of two successive long-term periods means long-term stability in the underlying factor structure, whereas non-invariance indicates the existence of instable elements in the factor patterns.

Transformation analysis possesses several advantages in analysing the stability of the factor patterns when compared for example with correlation or congruency analysis. With correlation and congruency coefficients one can only measure the degree of similarity of two factor solutions (correlations or congruencies among factor loadings across the variables in the factor space). This is also possible via transformation analysis (coefficients of coincidence on the main diagonal of the transformation matrix). In addition to this we obtain a regression type model for shifting of variables from one factor to another (normal or explained transformation). This is reveal by the non-zero off-diagonal elements in the transformation matrix and indicates interpretatively changes for the factors in question. And at last, large elements in the residual matrix, if any, indicate abnormal or unexplained transformation between the two factor solutions. This means that the empirical content of the corresponding variables has changed. Further, this abnormal transformation can be appointed to separate variables or to separate factors (cf. (3.23) and (3.24)).

4. EMPIRICAL RESULTS

In this chapter we will first analyze some of the macro-economic features of US economy, using the time series of value-weighted and equal-weighted indices of financial ratios. Thereafter we will develop empirically-based classification patterns for the presented financial ratios and measure the time-series stability of the classification patterns of the ratios. Finally, we will compare the dependence between stock market prices and the profitability ratios on the aggregate level.

4.1. The description and interpretation of the US economy-wide financial ratio indices

In this section we discuss the time series of economy-wide financial ratios. Appendix 3 presents the graphs of the ratios to be analyzed (value-weighted indices only). Table 1, however, presents the growth rates of the selected ratios, the growth rates being computed both for equal-weighted and for value-weighted indices. Comparing the two types of time-series of the economy-wide indices, it is possible to see the impact of the aggregation method in the numerical values of the indices. In addition, it is possible to see differences in the development of the examined ratios between "small" and "big" firms.

Table 1 presents the first and last smoothened observations for each variable. The smoothened values of the indices have been computed using an estimated linear regression model, time being the explanatory variable. Via this method, the impact of exceptionally high or low observations at the beginning or at the end of time series is eliminated and the numbers show better the "true" long-term development of the ratios.

The liquidity ratios in Table 1 are CR (current ratio), QR (quick ratio) and DI (defensive interval measure). The development of these time-series which describe the economy-wide liquidity of US corporations shows that the liquidity of the firms has been going down during the whole period examined. The numbers show further that the development has been especially strong among big firms. This conclusion can be made by comparing the value-and equal-weighted indices. In addition, the liquidity of small firms has been better than that of big firms during the period examined. All liquidity ratios have developed in the same direction. However, the defensive interval measure, which incorporates a dynamic element in liquidity evaluation, has changed considerably less than other liquidity ratios.

Table 1. Development of the ratios (as smoothened values) during the period 1947-1975.

Aggregation method	Year	Ratio CR	QR	DI	DE	LTDE	TIE
Value-weighted averages	1947	2.65	1.65	105	0.43	0.26	13.5
	1975	1.55	1.00	85	0.95	0.40	2.0
Equal-weighted averages	1947	3.30	1.85	110	0.45	0.34	23.5
	1975	2.35	1.50	100	1.30	0.65	1.5

Aggregation method	Year	Ratio ES	ROA	ROE	TAT	IT	ART
Value-weighted averages	1947	0.083	0.094	0.145	1.10	5.75	9.00
	1975	0.063	0.038	0.115	0.60	6.90	4.80
Equal-weighted averages	1947	0.084	0.100	0.165	1.50	8.85	16.20
	1975	0.065	0.052	0.125	1.20	12.60	8.50

The development of the long-term solvency ratios DE (debt to equity), LTDE (long-term debt to equity) and TIE (times interest earned) shows first that both long-term and short-term debt have increased a lot in US corporations (the leverage ratios of US corporations are, however, very low compared with those of most European firms (see Stonham 1978)). The increase of short-term debt has been faster than that of long-term debt. This increase has been especially fast among small firms. The analysis of residual terms in regression models shows that the development of leverage ratios has not been exactly linear. The residual term seems to be considerably parabolic. One can, however, argue that the presented numbers show the right long-term development of these ratios.

The changes of ratio TIE - a dynamic long-term solvency ratio - have diminished very strongly during the period examined. This can be seen from the residual term of the time series presented in Appendix 3 or even more clearly from the first differences of this variable.

The development of the profitability ratios ES (earning to sales), ROA (return on assets) and ROE (return on equity) in Table 1 shows that the profitability of small firms has been better than that of big firms during the whole period (especially when measured with ROA or ROE). On the other hand, the change of those ratios has been quite similar among small and big firms. Only the ratio ROA has gone down faster among big firms. This ratio measures how efficiently total assets are utilized by the firms.

Turnover ratios measure different aspects of a firm's performance. First, the development of variable TAT, total assets turnover, which is connected to profitability ratios via the Du Pont system (see 2.1.4. and 3.1.) is considered. The development of this variable is very interesting. Appendix 3 shows that there are two different levels in the time-series of this ratio. The first level appeared in the years 1947-56 (value-weighted averages about 1.1) and the second in the years 1961-75 (value-weighted averages about 0.6). The very fast fall from the first level to the second was caused by the postwar boom in the years 1956-60 (see Baumol and Blinder 1982: 27-35). On an average, small firms have had a higher TAT than big firms.

Inventory turnover (IT) of US corporations has risen during the period examined. Both the level and the rise of this ratio have been higher among small firms.

The development of ART, accounts receivable turnover, has been opposite. The fall of this ratio (about 45 %) has been approximately the same among big and small firms. However, the level of this ratio has been considerably higher among small than among big firms.

4.2. Classification patterns of the financial ratios

Correlation coefficients between the selected ratios for the period 1947-75 are presented in Tables 2 and 3. The corresponding correlation coefficients between the first differences of these ratios are presented in Tables 4 and 5. The letter E or W appearing in the abbreviation of a ratio indicates that the economy-wide index of the ratio has been computed as an equal-weighted or as a value-weighted average, respectively. And the letter D at the end of the whole symbol (e.g. ROAWD) indicates that the first differences of the ratio are considered.

The numerical values of most of the correlation coefficients in Tables 2 and 3 are very high. This implicates, in principle, a high degree of covariability among the ratios. However, the correlation coefficients between time and different ratios are very high (time is also a variable in matrices 2 and 3). This means a positive or negative linear trend in ratios. By removing the trend from the variables we see the "real" correlation coefficients between the ratios. This is done by working with the first differences of the variables (Tables 4 and 5). The correlation matrices in Tables 4 and 5 are therefore a better basis than matrices in Table 2 and 3 in evaluating the properties the ratios really measure.

4.2.1. Financial ratio patterns using economy-wide ratio indices

Our factor-analytic derivation of the financial ratio patterns begins with the original level values of the aggregated ratios (factor analysis is based on the correlation matrices in Tables 2 and 3). The four factors found via Kaiser's orthogonal varimax rotation are presented in Tables 6 and 7. The results in Table 6 are based on value-weighted averages and in Table 7, respectively, on the equal-weighted averages of the ratios. The number of factors to be extracted can be determined by using different criteria e.g. a priori knowledge, interpretative aspects, the eigenvalue criterion or Cattell's scree test. In this study, the number of factors extracted is mainly based on interpretative aspects and on a priori knowledge (i.e. the number of classes in the original classification). However, in most cases the eigenvalues associated with each factor exceed 1.

The form of all factor loading matrices to be presented in this study is the following. First, the columns (factors) appear in decreasing order of variance explained by the factors. The rows (variables) are rearranged so that, for each successive factor, loadings greater than 0.5 appear first. Loadings less than 0.25 are replaced by zero.

Table 2. Correlation matrix of the ratios (ratios computed as value-weighted averages).

	TIME	CRW	QRW	DIW	DEW	LTDEW	TIEW	ESW	ROAW	ROEW	TATW	ITW	ARTW
TIME	1.000												
CRW	-0.912	1.000											
QRW	-0.849	0.971	1.000										
DIW	-0.804	0.772	0.838	1.000									
DEW	0.903	-0.964	-0.958	-0.807	1.000								
LTDEW	0.647	-0.843	-0.892	-0.664	0.878	1.000							
TIEW	-0.956	0.799	0.724	0.748	-0.774	-0.456	1.000						
ESW	-0.644	0.656	0.695	0.661	-0.716	-0.689	0.618	1.000					
ROAW	-0.880	0.718	0.635	0.654	-0.693	-0.344	0.956	0.643	1.000				
ROEW	-0.505	0.271	0.203	0.323	-0.236	0.080	0.696	0.551	0.816	1.000			
TATW	-0.895	0.718	0.616	0.628	-0.703	-0.311	0.937	0.432	0.941	0.646	1.000		
ITW	0.773	-0.781	-0.680	-0.510	0.703	0.626	-0.673	-0.282	-0.510	-0.068	-0.597	1.000	
ARTW	-0.937	0.786	0.694	0.685	-0.735	-0.398	0.976	0.549	0.950	0.704	0.938	-0.656	1.000

Table 3. Correlation matrix of the ratios (ratios computed as equal-weighted averages).

	TIME	CRE	QRE	DIE	DEE	LTDEE	TIEE	ESE	ROAE	ROEE	TATE	ITE	ARTE
TIME	1.000												
CRE	-0.813	1.000											
QRE	-0.614	0.889	1.000										
DIE	-0.622	0.523	0.609	1.000									
DEE	0.962	-0.887	-0.699	-0.584	1.000								
LTDEE	0.884	-0.923	-0.808	-0.546	0.963	1.000							
TIEE	-0.921	0.642	0.444	0.636	-0.826	-0.709	1.000						
ESE	-0.539	0.454	0.472	0.505	-0.524	-0.560	0.572	1.000					
ROAE	-0.801	0.531	0.332	0.542	-0.705	-0.597	0.941	0.686	1.000				
ROEE	-0.414	0.108	-0.010	0.330	-0.263	-0.154	0.687	0.558	0.832	1.000			
TATE	-0.881	0.531	0.308	0.522	-0.782	-0.638	0.919	0.434	0.867	0.601	1.000		
ITE	0.846	-0.821	-0.541	-0.362	0.848	0.798	-0.747	-0.254	-0.599	-0.232	-0.658	1.000	
ARTE	-0.983	0.793	0.561	0.539	-0.954	-0.867	0.916	0.484	0.805	0.433	0.901	-0.848	1.000

Table 4. Correlation matrix of the first differences of the ratios (ratios computed as value-weighted averages).

	CRWD	QRWD	DIWD	DEWD	LTDEWD	TIEWD	ESWD	ROAWD	ROEWD	TATWD	ITWD	ARTWD
CRWD	1.000											
QRWD	0.849	1.000										
DIWD	0.143	0.548	1.000									
DEWD	-0.713	-0.725	-0.269	1.000								
LTDEWD	-0.832	-0.792	-0.173	0.763	1.000							
TIEWD	-0.410	-0.219	0.262	0.236	0.399	1.000						
ESWD	-0.193	0.011	0.287	-0.173	0.080	0.518	1.000					
ROAWD	-0.478	-0.276	0.174	0.210	0.468	0.657	0.815	1.000				
ROEWD	-0.525	-0.351	0.071	0.256	0.521	0.662	0.841	0.945	1.000			
TATWD	-0.577	-0.464	-0.046	0.404	0.621	0.383	0.273	0.712	0.583	1.000		
ITWD	-0.606	-0.320	0.220	0.265	0.621	0.496	0.654	0.803	0.844	0.645	1.000	
ARTWD	-0.578	-0.428	-0.061	0.465	0.654	0.567	0.324	0.670	0.692	0.653	0.728	1.000

Table 5. Correlation matrix of the first differences of the ratios (ratios computed as equal-weighted averages).

	CRED	QRED	DIED	DEED	LTDEED	TIEED	ESED	ROAED	ROEED	TATED	ITED	ARTED
CRED	1.000											
QRED	0.930	1.000										
DIED	0.212	0.454	1.000									
DEED	-0.465	-0.390	-0.082	1.000								
LTDEED	-0.633	-0.592	-0.147	0.873	1.000							
TIEED	-0.567	-0.377	0.369	0.123	0.269	1.000						
ESED	-0.267	-0.114	0.280	-0.045	0.021	0.652	1.000					
ROAED	-0.544	-0.453	0.156	0.060	0.246	0.852	0.762	1.000				
ROEED	-0.549	-0.380	0.238	0.128	0.256	0.728	0.717	0.787	1.000			
TATED	-0.688	-0.602	-0.163	0.311	0.425	0.462	0.404	0.652	0.505	1.000		
ITED	-0.460	-0.280	0.311	0.375	0.483	0.515	0.525	0.613	0.593	0.587	1.000	
ARTED	-0.198	-0.291	-0.521	-0.214	-0.136	0.001	0.132	0.193	0.187	0.278	0.107	1.000

Table 6. Varimax-rotated factor matrix for value-weighted averages.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality h_i^2
ROEW	**0.974**	0.000	0.000	0.000	0.985
ROAW	**0.883**	0.290	-0.287	0.000	0.987
ARTW	**0.792**	0.253	-0.465	0.263	0.977
TIEW	**0.778**	0.324	-0.437	0.289	0.984
TATW	**0.775**	0.000	-0.471	0.338	0.953
LTDEW	0.000	**-0.889**	0.414	0.000	0.992
ESW	0.481	**0.862**	0.000	0.000	0.984
QRW	0.000	**0.750**	-0.453	0.379	0.967
DEW	-0.303	**-0.722**	0.493	-0.328	0.964
CRW	0.336	**0.659**	-0.589	0.278	0.972
ITW	0.000	-0.293	**0.899**	0.000	0.936
DIW	0.348	0.577	0.000	**0.684**	0.956
Variance explained by the factor	4.212	3.747	2.555	1.141	
Cumulative proportion of total variance	0.351	0.663	0.876	0.971	

Table 7. Varimax-rotated factor matrix for equal-weighted averages.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality h_i^2
CRE	**0.920**	0.000	0.000	0.000	0.956
LTDEE	**-0.901**	0.000	0.000	0.000	0.962
DEE	**-0.865**	-0.396	0.000	0.000	0.966
ITE	**-0.861**	-0.380	0.000	0.000	0.898
ARTE	**0.766**	0.600	0.000	0.000	0.973
QRE	**0.749**	0.000	0.456	0.372	0.926
ROEE	0.000	**0.885**	0.000	0.339	0.914
ROAE	0.354	**0.863**	0.000	0.293	0.978
TATE	0.476	**0.810**	0.000	0.000	0.925
TIEE	0.521	**0.795**	0.259	0.000	0.981
DIE	0.283	0.307	**0.885**	0.000	0.983
ESE	0.000	0.397	0.000	**0.836**	0.950
Variance explained by the factor	5.069	3.804	1.324	1.215	
Cumulative proportion of total variance	0.422	0.739	0.850	0.951	

Table 6 shows that the four factor solution accounts for 97.1 per cent of the total variance in the original twelve financial ratios when value-weighted averages of the ratios are used. The corresponding value by using equal-weighted averages is 95.1 per cent. The communalities of all variables are also high. However, the interpretation of those factor solutions is not easy.

The financial ratios which achieve the highest factor loadings on the first factor in Table 6 are ROE (return on equity), ROA (return on assets), ART (accounts receivable turnover), TIE (time interest earned) and TAT (total assets turnover). The first factor can be interpreted as **a factor of profitability and efficiency.** However, the loading of ES (earnings to sales), supposed to be a profitability measure a priori, and the loading of IT (inventory turnover) an efficiency measure a priori, are quite low on the first factor. In addition, the loading of TIE (time interest earned), a long-term solvency variable a priori, is high on this factor.

The second factor can be interpreted as **a factor of solvency.** The variable LTDE (long-term debt to equity), ES (earnings to sales), QR (quick ratio), DE (debt to equity) and CR (current ratio) have high loadings on this factor. All these variables, excluding ES, were, a priori, measures of either short- or long-term solvency.

The third factor indicates **the efficiency of the firms' inventory management.**

The fourth factor can be interpreted as a factor of **dynamic liquidity.**

The four factor solution, based on the equal-weighted averages of the ratios, is presented in Table 7. The interpretation of the first factor in Table 7 is, to some extent, similar to the interpretation of the second factor in Table 6. This factor describes, in the first place, the **solvency** of the firm. However, also the variables IT and ART (turnover measures a priori) achieve high loadings on this factor (the loadings being even provided with different signs).

The second factor in Table 7 can be interpreted as a **factor of profitability.** The third factor indicates **dynamic liquidity** of the firm.

The variable ES (earning to sales) creates a factor of its own in the solution of Table 7.

Summarizing, although the explained variances and communalities in Tables 6 and 7 are very high, the interpretation of the factors is not easy. This is especially true when the factor solution based on equal-weighted averages is concerned. In addition, the obtained factor solutions in Tables 6 and 7 differ a lot from each other. The reason for this numerically satisfactory but interpretatively confusing situation is quite clear: the high seeming correlations among the variables caused by time.

4.2.2. Financial ratio patterns using first differences of the ratios

The factor solutions found by using the first differences of the selected ratios are presented in Tables 8 and 9. The four factor solutions account for 87.8 per cent (Table 8) and 86.4 per cent (Table 9) of the total variances in the original variables. The obtained values are slightly lower than those presented in Tables 6 and 7 because the trend is now removed from the variables.

The interpretation of the first factor in Table 8 is clear and unambigious. The financial ratios which achieve the highest loadings on this factor are DE, CR, LTDE and QR. This factor decribes **the solvency of the firms.** (In fact, the factor model being based on the first differences of the ratios, also the interpretation of the factor should be the **change** of the solvency of the firms. For the sake of simplicity and clarity, all the factors are named according to basic quantifies themselves, however.).

The second factor can be interpreted as a factor of **profitability.** The interpretation of this factor is also easy. Only the high loading of the variable TIE (times interest earned) on this factor requests an explanation. This variable was, according to the a priori classification, the measure of dynamic long-term solvency. However, Table 8 and also the following results show that TIE is rather the measure of profitability than that of long-term solvency.

The third factor describes the **efficiency** of the firm. The variables with the highest loadings on this factor are, in correspondence with a priori classification, the three turnover ratios selected for this study.

Table 8. Varimax-rotated factor matrix for the first differences of value-weighted averages.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality h_i^2
DEWD	**-0.895**	0.000	0.000	0.000	0.832
CRWD	**0.834**	-0.272	-0.281	0.000	0.854
LTDEWD	**-0.834**	0.000	0.411	0.000	0.895
QRWD	**0.834**	0.000	0.000	0.454	0.935
ESWD	0.000	**0.942**	0.000	0.000	0.942
ROEWD	0.000	**0.874**	0.384	0.000	0.970
ROAWD	0.000	**0.813**	0.506	0.000	0.946
TIEWD	-0.394	**0.709**	0.000	0.358	0.785
TATWD	-0.338	0.000	**0.821**	0.000	0.850
ITWD	-0.271	0.613	**0.621**	0.000	0.858
ARTWD	-0.454	0.412	**0.590**	0.000	0.725
DIWD	0.000	0.000	0.000	**0.928**	0.943
Variance explained by the factor	3.607	3.568	2.124	1.235	
Cumulative proportion of total variance	0.301	0.598	0.775	0.878	

Table 9. Varimax-rotated factor matrix for the first differences of equal-weighted averages.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality h_i^2
ROAED	**0.901**	0.000	-0.282	0.000	0.899
ESED	**0.875**	0.000	0.000	0.000	0.776
ROEED	**0.857**	0.000	0.000	0.000	0.787
TIEED	**0.837**	0.000	-0.345	0.000	0.882
ITED	**0.703**	-0.590	0.000	0.000	0.885
TATED	**0.548**	-0.398	-0.336	-0.370	0.708
DEED	0.000	**-0.913**	0.000	0.000	0.891
LTDEED	0.000	**-0.877**	-0.375	0.000	0.923
QRED	0.000	0.328	**0.851**	0.269	0.948
CRED	-0.407	0.411	**0.759**	0.000	0.928
ARTED	0.000	0.000	0.000	**-0.906**	0.877
DIED	0.427	0.000	0.455	**0.691**	0.867
Variance explained by the factor	4.235	2.430	2.077	1.629	
Cumulative proportion of total variance	0.353	0.555	0.728	0.864	

The fourth factor indicates the **dynamic short-term solvency** of the firm. This factor is a very pure one-variable (DI) factor, because the loadings of other ratios are very low on this factor.

We see that the interpretation of the financial ratio classification which is based on the first differences of the value-weighted indices of the ratios, becomes very clear-cut compared with the results obtained from the original level values of the financial ratios (Tables 6 and 7).

Table 9 shows the results based on the first differences of the equal-weighted averages of the financial ratios. The first factor in Table 9 is an indicator of **profitability and efficiency** of the firms. This factor includes the main parts (ART excluded) of the second and third factor presented in Table 8.

The first factor in the value-weighted average solution in Table 8 (the solvency factor), is in Table 9 divided into two factors: a factor of **long-term solvency** (the second factor) and a factor of **short-term solvency** (the third factor).

The fourth factor can be interpreted - as in Table 8 - as a factor of **dynamic liquidity.** However, that interpretation proves difficult, because of the high negative loading of the variable ART on this factor.

The inconsistency in the behaviour of the variable ART between Tables 8 and 9 derives its origin probably from the very different role of accounts receivable when we have computed the values of variable DI among small and big firms (for the definition of the ratios, see Appendix 1). Thus, different aggregation methods lead to the very different results. Also other differences, caused by different aggregation methods can be found between the factor patterns presented in Tables 8 and 9. These differences are analyzed in a more detailed way in Chapter 4.3. The presented results (Tables 6-9) confirm that the use of the variables in first-difference form lead to a more valid classification pattern than the classification pattern of original ratios. Further, the results also suggest that the value-weighted indices give, in addition to that they are theoretically more accurate, more clear-cut classifications of the financial ratios than the equally-weighted indices. The differences between these two classifications are analyzed in greater detail in Chapter 4.3. by using transformation analysis.

It is difficult to find clear theoretical arguments why the factors extracted from financial ratios should be uncorrelated. Therefore, the results presented in Tables 8 and 9 are verified with a non-ortogonal rotation method. However, based on earlier theoretical and empirical arguments, the non-orthogonal results are presented only for value-weighted variables in first-difference form. Table 10 shows that the non-orthogonal factor pattern is very similar to the orthogonal factor pattern (Table 8). Table 11 presents correlation coefficients between the factors within the oblique factor solution. Firstly, the solvency factor seems to be non-orthogonal both to the profitability and efficiency factors. The correlations between those factors are -.227 and -.445, respectively. This result can be interpreted as follows: maintenance of high solvency has a slightly decreasing effect on efficiency and profitability. Second, the correlation between profitability factor and efficiency factor is .421. The positive correlation coefficient suggests that although the profitability and efficiency ratios measure different dimensions of the firms' performance those dimensions are not independent. The fourth factor (dynamic short-term solvency) clearly measures quite an independent dimension in the firms' behaviour.

The oblique factor solution (Table 10) mainly supports the findings for the corresponding orthogonal solution (Table 8). On the other hand, it gives valuable additional information about the interdependencies existing between the main dimensions of the financial ratios. Due to the strong similarity between these two solutions, the subsequent analysis will be restricted, however, to orthogonal factor models only.

Table 10. Quartimin-rotated factor matrix (pattern loadings) for the ratios (for the value-weighted averages in the first difference form).

Variable	Factor 1	Factor 2	Factor 3	Factor 4
DEWD	**-0.915**	0.000	0.000	0.000
CRWD	**0.799**	0.000	0.000	0.000
QRWD	**0.783**	0.000	0.000	0.449
LTDEWD	**-0.768**	0.000	0.321	0.000
ESWD	0.255	**0.996**	0.000	0.000
ROEWD	0.000	**0.822**	0.255	0.000
ROAWD	0.000	**0.708**	0.421	0.000
TIEWD	-0.466	**0.638**	0.000	0.333
TATWD	0.000	0.000	**0.868**	0.000
ITWD	0.000	0.421	**0.576**	0.000
ARTWD	-0.308	0.000	**0.547**	0.000
DIWD	0.000	0.000	0.000	**0.958**

Table 11. Factor correlations for quartimin-rotated factors.

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	1.000			
Factor 2	-0.227	1.000		
Factor 3	-0.445	0.421	1.000	
Factor 4	0.133	0.261	-0.007	1.000

4.3. The long-term stability of financial ratio patterns

One of the objectives in this study was to measure, using transformation analysis, the long-term stability of factor patterns obtained. For this analysis, the whole period is divided into two sub-periods of equal length: sub-period 1 includes the years 1947-61 and sub-period 2 the years 1962-75.

Chapter 4.2. shows that empirical results based on the variables in the first-difference form are very clear-cut compared to those in ratio forms. This indicates that the difference-formed models should be preferred to the level-formed models. Therefore, stability analysis presented in this section is based only on the variables in the first-difference form.

Tables 12 and 13 show, value-weighted variables being used, the four factor solutions for sub-period 1 and for sub-period 2, respectively. The four factor solutions account for 91.2 per cent (Table 12) and 91.3 per cent (Table 13) of the total variances in the original variables. The corresponding number for the whole period was 87.8 (Table 8).

The four factor solution for sub-period 1 is quite similar to that of the whole period. The major difference between those two solutions is in the loadings of the variables IT and ART. Those variables have the highest loading on the profitability/efficiency factor in Table 12. In Table 8 those variables, together with the variable TAT, created more clearly an efficiency factor of their own (this efficiency factor still exists, however, in the solution of Table 12).

Table 12. Varimax-rotated factor matrix for the ratios (for the value-weighted averages in the first difference form) in sub-period 1.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality h_i^2
ESWD	**0.952**	0.000	0.000	0.000	0.943
ROEWD	**0.920**	-0.266	0.000	0.000	0.981
ROAWD	**0.879**	0.000	0.421	0.000	0.979
TIEWD	**0.755**	-0.432	0.000	0.295	0.876
ITWD	**0.623**	-0.433	0.547	0.000	0.915
ARTWD	**0.604**	-0.574	0.328	0.000	0.803
DEWD	0.000	**-0.913**	0.000	0.000	0.837
CRWD	-0.284	**0.867**	-0.291	0.000	0.924
LTDWD	0.000	**-0.861**	0.335	0.000	0.908
QRWD	0.000	**0.799**	0.000	0.500	0.928
TATWD	0.332	-0.385	**0.792**	0.000	0.886
DIWD	0.000	0.000	0.000	**0.955**	0.959
Variance explained by the factor	4.137	3.943	1.553	1.307	
Cumulative proportion of total variance	0.345	0.673	0.803	0.912	

Table 13. Varimax-rotated factor matrix for the ratios (for the value-weighted averages in the first difference form) in sub-period 2.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality h_i^2
ROEWD	**0.930**	0.000	0.279	0.000	0.970
ESWD	**0.897**	0.000	0.000	0.286	0.939
ITWD	**0.896**	0.000	0.359	0.000	0.953
ROAWD	**0.888**	0.000	0.328	0.000	0.967
TIEWD	**0.579**	0.571	-0.321	-0.293	0.850
QRWD	0.000	**0.961**	0.000	0.000	0.970
CRWD	0.000	**0.924**	0.000	0.000	0.900
DEWD	0.000	**-0.840**	0.000	-0.263	0.814
LTDEWD	0.278	**-0.802**	0.356	0.000	0.903
ARTWD	0.000	0.000	**0.920**	0.000	0.909
TATWD	0.371	-0.257	**0.654**	-0.525	0.906
DIWD	0.000	0.543	0.000	**0.695**	0.870
Variance explained by the factor	3.963	3.922	1.918	1.150	
Cumulative proportion of total variance	0.330	0.657	0.817	0.913	

The factor solution for sub-period 2 is more close to the solution of the whole period than that for sub-period 1. Now only the variable IT changes the factor. It transfers from efficiency factor to profitability factor (in the whole period vs. sub-period 2).

Table 14 presents the transformation matrix between the factors for sub-period 1 (Table 12) and sub-period 2 (Table 13). The factors were calculated on the basis of value-weighted indices, and in the first-difference form they display considerable long-term stability. This conclusion is based on the coefficients of coincidence on the main diagonal of the transformation matrix. The numerical values of those coefficients are very close to 1. In addition, the transformation matrix shows a slight transference between the first and fourth factors. This result confirms apparent differences between the variable DI (dynamic liquidity) and other liquidity or short-term solvency measures (CR and QR). The variable DI loads on a separate and distinct factor which has a weak connection with the profitability factor.

Table 15 presents the residual matrix for sub-period 2 (matrix E_{12}). Zero elements in residual matrix mean that the variables in question measure the same characteristic of the firms' performance during different periods. Non-zero elements in residual matrix mean that the empirical meaning of the variables in question has changed.

The residual matrix shows that there are only two variables with a moderately high abnormal transformation. The abnormal transformation of the variable TIE can be designated to the factors 1, 2 and 4. This variable was in the a priori classification the measure of long-term solvency. However, during the first sub-period, this ratio was, in the first place, the measure of profitability. The great negative numerical value -0.850 on the second factor in residual matrix shows that the feature measuring long-term solvency increases considerably in variable TIE during the second sub-period. The abnormal transformation of the variable ART is high on the first, second and third factors. It means that the empirical content of this variable has changed. However, the transformation and residual matrices in Tables 14 and 15 indicate a very high long-term stability of the factor pattern.

Table 14. Transformation matrix between the factor patterns of ratios in sub-period 1 and sub-period 2 (factors based on the first differences of the value-weighted averages of the ratios).

		Sub-period 2			
	Factor	1	2	3	4
Sub-period 1	1	**0.954**	0.145	-0.080	-0.249
	2	-0.178	**0.978**	-0.039	-0.100
	3	0.056	0.042	**0.994**	-0.080
	4	0.234	0.143	0.058	**0.960**

Table 15. Residual matrix E_{12} and abnormal transformation for sub-period 2 (factors based on the first differences of the value-weighted averages of the ratios).

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Abnormal transformation t_i^2
CRWD	-0.227	-0.118	-0.350	0.161	0.214
QRWD	-0.171	-0.133	-0.102	0.230	0.111
DIWD	0.105	-0.249	0.277	0.165	0.177
DEWD	0.190	-0.057	-0.122	0.327	0.161
LTDEWD	0.119	0.009	-0.008	0.240	0.072
TIEWD	0.277	-0.850	0.115	0.446	**1.010**
ESWD	0.007	0.106	0.226	-0.510	0.322
ROAWD	0.019	0.197	0.031	0.026	0.041
ROEWD	0.002	0.032	-0.095	-0.197	0.049
TATWD	0.058	-0.039	0.122	0.413	0.190
ITWD	-0.147	-0.151	0.164	-0.035	0.072
ARTWD	0.480	-0.360	-0.618	-0.026	**0.742**
Abnormal transformation s_j^2	0.474	1.024	0.722	0.941	3.161

Tables 16 and 17 present for sub-period 1 and for sub-period 2, respectively, the four factor solutions based on the equal-weighted indices in the first-difference form. The factor pattern in Table 16 is very similar to that obtained by using value-weighted averages of variables in the first difference form (Tables 8, 12 and 13). Table 16 includes four different factors: profitability, solvency, dynamic liquidity and efficiency.

Table 16. Varimax-rotated factor matrix for the ratios (for the equal-weighted averages in the first difference form) in sub-period 1.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality h_i^2
ROAED	**0.934**	0.000	0.000	0.000	0.937
TIEED	**0.912**	-0.284	0.000	0.000	0.954
ESED	**0.902**	0.000	0.000	0.000	0.845
ROEED	**0.896**	0.000	0.000	0.293	0.932
LTDEED	0.000	**-0.949**	0.000	0.000	0.922
DEED	0.000	**-0.873**	0.000	0.000	0.860
QRED	-0.366	**0.839**	0.377	0.000	0.980
CRED	-0.470	**0.831**	0.000	0.000	0.963
ARTED	0.000	0.000	**-0.925**	0.000	0.903
DIED	0.315	0.292	**0.844**	0.000	0.930
ITED	0.626	0.000	0.000	**0.719**	0.960
TATED	0.383	-0.509	0.000	**0.705**	0.937
Variance explained by the factor	4.356	3.594	1.865	1.307	
Cumulative proportion of total variance	0.363	0.663	0.818	0.927	

Table 17. Varimax-rotated factor matrix for the ratios (for the equal-weighted averages in the first difference form) in sub-period 2.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality h_i^2
QRED	**0.946**	0.000	0.000	0.000	0.942
CRED	**0.859**	0.000	0.279	-0.308	0.928
DIED	**0.786**	0.000	0.000	0.445	0.819
TIEED	0.000	**0.909**	0.000	0.000	0.870
ROAED	-0.474	**0.745**	0.000	0.323	0.921
TATED	-0.630	**0.703**	0.000	0.000	0.896
ESED	0.293	**0.650**	0.000	0.613	0.893
ARTED	-0.415	**0.542**	0.350	0.000	0.617
DEED	0.000	0.000	**-0.967**	0.000	0.938
LTDEED	0.000	0.000	**-0.953**	0.000	0.955
ITED	0.000	0.485	**-0.628**	0.316	0.739
ROEED	0.000	0.000	0.000	**0.902**	0.887
Variance explained by the factor	3.232	2.887	2.538	1.749	
Cumulative proportion of total variance	0.269	0.510	0.721	0.867	

On the contrary, the factor solution in Table 17 differs considerably from the solutions presented in Tables 8, 12, 13 and 16. The first factor describes the short-term solvency of the firms. The variables, which according to the a priori classification serve as the measures of liquidity, have the highest loadings on this factor (exceptionally also the variable DI). The second factor can be interpreted as a factor of profitability and efficiency. The third factor describes the long-term solvency of the firms. Finally, the variable ROE creates a factor of its own.

Table 18 presents the transformation matrix between the factors given in Tables 16 and 17. The transformation matrix shows that the long-term stability between factor patterns is very low. The first factor given in Table 16 is divided in the first place to the second and fourth factors during the second period. The second factor is divided to the first and third factors etc. Table 19 presentes the residual matrix involved. The residual matrix shows that, in spite of the considerable instability associated with the factors, any remarkable abnormal transformation does not exist. The empirical meaning has changed only among factors, not among variables. Only the variables TIE and ROE have some noticeable abnormal transformation.

Table 14 indicates a very high long-term stability between factor patterns when the variables are value-weighted indices in the first-difference form. On the other hand, the results presented in Table 18 give evidence of considerable instability between factor patterns when the variables are equally-weighted indices in the first-difference form. These results prove that the role of the aggregation method is very important, when we consider and calculate some industry-wide or economy-wide norms to be "target financial ratios" for firms.

Table 18. Transformation matrix between the factor patterns of ratios in sub-period 1 and sub-period 2 (factors based on the first differences of the equal-weighted averages of the ratios).

		Sub-period 2			
	Factor	1	2	3	4
Sub-period 1	1	-0.101	**0.556**	0.038	**0.824**
	2	**0.622**	0.175	**0.759**	-0.077
	3	**0.768**	-0.186	**-0.562**	0.246
	4	0.114	**0.791**	-0.327	**-0.504**

Table 19. Residual matrix E_{12} and abnormal transformation for sub-period 2 (factors based on the first differences of the equal-weighted averages of the ratios).

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Abnormal transformation t_i^2
CRED	-0.177	-0.133	0.283	-0.028	0.130
QRED	-0.095	-0.106	0.229	-0.158	0.097
DIED	0.033	0.214	-0.234	-0.093	0.110
DEED	-0.344	-0.087	0.141	-0.156	0.170
LTDEED	-0.336	-0.105	0.165	0.043	0.153
TIEED	-0.240	-0.462	-0.194	0.690	**0.785**
ESED	-0.353	-0.013	0.190	0.040	0.162
ROAED	0.308	-0.060	0.086	0.333	0.216
ROEED	0.005	0.492	-0.162	-0.290	**0.352**
TATED	0.214	0.013	-0.463	0.010	0.260
ITED	0.118	0.375	0.204	-0.114	0.209
ARTED	-0.210	-0.176	0.226	-0.387	0.276
Abnormal transformation s_j^2	0.654	0.724	0.649	0.896	2.922

In the following, we will further consider, if the importance of the aggregation method has changed during the period examined. Therefore, we compare the factor patterns given in Tables 12 and 16 via transformation analysis. The factor patterns given in Tables 13 and 17 are compared analogously.

Table 20 shows that during the first sub-period, years 1947-61, the role of aggregation method has not been very important. The numerical values of the coefficients of coincidence are very high (0.986, 0.993, 0.961 and 0.947). On the contrary, the situation changes totally during the second sub-period (years 1962-75, results in Table 21). The transformation matrix shows that the factor solutions in Tables 13 and 17 differ considerably from each other.

Table 20. Transformation matrix between the factor patterns based on different aggregation methods of ratios (sub-period 1).

		Value-weighted averages			
	Factor	1	2	3	4
Equally-weighted averages	1	**0.986**	-0.097	-0.031	0.131
	2	0.086	**0.993**	-0.009	0.086
	3	-0.141	-0.072	-0.274	**0.949**
	4	-0.008	-0.014	**0.961**	0.275

Table 21. Transformation matrix between the factor patterns based on different aggregation methods of ratios (sub-period 2).

		Value-weighted averages			
	Factor	1	2	3	4
Equally-weighted averages	1	0.121	**0.642**	**-0.721**	0.231
	2	**0.720**	0.342	0.248	**-0.551**
	3	0.367	**0.674**	**0.606**	0.211
	4	**0.577**	-0.133	0.227	**0.773**

The comparison of the transformation matrices given in Tables 14, 18, 20 and 21 shows that the value-weighted indices in the first-difference form give very stable factor solutions during the whole period examined. When equal-weighted indices were used, the factor pattern was very similar to that based on value-weighted indices during the first sub-period. The situation changes radically during the second sub-period. The result means that the numerical values of financial ratios differ systematically from each other among small and big firms during the latter period.

4.4. Evaluation of the analysis and some further implications

The specific purposes in the Sections 4.2. and 4.3. were to develop empirically based classification patterns of financial ratios and to measure and model the long-term stability of those factor patterns between two sub-periods.

The results, concerning the whole period examined, were first based on the value-weighted and on the equal-weighted averages of the selected ratios. The number of factors extracted was determined in the first place by a priori knowledge and interpretative aspects. Although the explained variances of those factor patterns were high, the interpretation of the results was difficult. The high correlation between time and different ratios was one potential reason for the difficulties. The use of the first differences of ratios removed the trend from the variables.

The factor solution in Table 8, found by using the first differences of the weighted averages of the ratios, was clear-cut and easy to interprete. The classification was not, however, equivalent to the a priori classification. We found the following factors: solvency, profitability, efficiency and dynamic liquidity. An interesting feature was that the short-term solvency and long-term solvency did not differ from each other. In addition, the variable DI created its own factor for dynamic liquidity or short-term solvency factor and the variable TIE (the measure of long-term solvency a priori) measured more profitability than long-term solvency of the firms.

The clear-cut and easy-to-interprete factor solution in Table 8 proved also very stable. The solutions for the sub-periods 1 and 2 (Tables 12 and 13) were quite similar: the transformation matrix between these solutions (Table 14) was near to unity matrix with only a slight abnormal transformation (Table 15). On the contrary, the factor solution based on the first differences of the equal-weighted averages (Table 9) possessed no comparable stability. The instability was mainly caused by the exceptional behaviour of the equal-weighted averages during the latter sub-period. As a summary, the choose of aggregation method is of great importance in economy-wide ratio analysis. The results support strongly the use of value-weighted indices instead of equal-weighted indices.

Finally, we will determine the good financial ratios on the basis of our analysis. When utilizing the financial ratios, it is valuable to know the theoretical relationships between the classes of ratios under consideration. After choosing a small subset of ratios to be used, it is important to know the empirical behavior of these ratios. In this respect, we have four requirements for the good ratios. First, the factor solution should be clear-cut and easy to interprete. Second, the ratios should have high loading on one factor and low loadings on all the other factors. Third, the communality of the variable should be close to one, i.e. the factor solution examined should in practice explain, as much as possible, the total variation of the ratios in question. Fourth, the coefficient of coincidence in transformation matrix should be close to 1, and all elements in residual matrix close to zero; in that case the stability of the financial ratio pattern is high.

The final financial ratio pattern deduced through the analysis, the four factor solution found by using the first differences of the value-weighted averages of the ratios, was presented in Table 8. The classification of the ratios differed to some extent from the a priori classification. We found the following four factors: solvency, profitability, efficiency and dynamic liquidity.

The best solvency measures were DE (debt to equity) and QR (quick ratio), the former being, a priori, the measure of long-term solvency and the latter, a priori, the measure of short-term solvency. Respectively, the best profitability measure was ROE (return on equity). ROA (return on assets) and ES (earnings to sales) were also quite good measures of profitability. The fourth measure TIE (times interest earned; a priori the measure of long-term solvency) was, according to the criteria presented above, quite a poor profitability measure. It had a low communality and a very high abnormal transformation. TAT (total assets turnover) was very clearly the best efficiency ratio. The second best was IT (inventory turnover) and the worst ART (accounts receivable turnover). The fourth factor, dynamic liquidity was not included in the a priori classification. Only the variable DI (defensive interval) loaded strongly on this factor. DI measured very well this characteristic of firms' performance.

4.5. The profitability and stock prices

Empirical evidence indicates that stock price fluctuations are closely related to accounting earnings changes (see Section 1.2.). In this section, we will demonstrate the connection between those variables on the aggregate level. The demonstration is very simple and it is realized using annual data. Therefore, we cannot find any lead or lag between variables. So it is also impossible to say anything e.g. about how effectively investors use financial data.

The connections between the variables are analyzed using simple correlation technique without any theoretical models of assets valuation. All variables are in the first-difference form. The time series of the average annual stock price index (denoted IND) is presented in Appendix 4 (see Baumol and Blinder 1982: 31). The scatter diagrams in Appendix 5 show that we have two kinds of outliers in the data (we use ROA, both in the value-weighted and in the equal-weighted form, as an example to point the outliers). First, the years when the profitability is exceptional. Such years are the years at the beginning of the period: 1948, 1950 and 1951 (time before and at the beginning of Korean war). Therefore, the first four years are removed from the data. The second group of outliers appears in the years when the investors' expectations have radically changed (the stock prices have strongly gone down) without any corresponding change in profitability. Such years are 1962 (Cuban crisis), 1966 (Vietnam stagnation), 1969-70 (1970 recession) and 1973-74 (oil crisis) (see Baumol and Blinder 1982: 31). These years are also removed from the correlation analysis.

Table 22 shows the correlation coefficients between the average stock market prices and the ratios loaded on the profitability factor. All variables are in the first-difference form and profitability variables are, in addition, value and equally weighted indices. The results show that correlation coefficients differ, with one exception (value-weighted TIE), at least at the 0.01 level of significance from zero. The mutual dependence is real, because we havé removed the trend from time series.

Table 23 gives the correlation coefficients between the change of average stock market prices and all the four factors obtained (in addition to the orthogonal solution (Table 8) also the factors of the comparable non-orthogonal solution (Table 10) are considered). The interpretation of those coefficients is easy. The fluctuations of stock market prices and accounting earnings have been close to each other (the correlation coefficients differ statistically significantly from zero in both models). The results of the non-orthogonal rotation method showed that although the profitability and efficiency ratios measure different dimensions of the firms' performance, those dimensions are not totally independent. Therefore, the positive correlation between the change of average stock market prices and the efficiency factor (non-orthogonal model) was expected. The low negative correlation in the non-orthogonal case between the change of stock market prices and the solvency factor (not statistically significant, however) can be explained in the same way, referring to the results given in Table 11. The zero correlation of dynamic liquidity shows that the investors have not been interested in the liquidity of the firms.

Table 22. Correlations between average stock market prices and profitability ratios (all variables in the first difference form).

Ratio	Ratios as value-weighted averages	Ratios as equally-weighted averages
TIE	0.39	0.81***
ES	0.78***	0.72***
ROA	0.72***	0.78***
ROE	0.67**	0.79***

Table 23. Correlations between changes in average stock market prices and the four factors of ratios.

Factor	Varimax-rotated factor solution	Quartimin-rotated factor solution
Factor 1 (solvency)	-0.05	-0.21
Factor 2 (profitability)	0.62**	0.68**
Factor 3 (efficiency)	0.39	0.51*
Factor 4 (dynamic liquidity)	0.09	0.18

5. SUMMARY

The purpose of this study was to develop, on the economy-wide level, an empirically-based classification pattern for 12 commonly used financial ratios. The selected ratios were according to a priori classification the measures of short-term solvency, long-term solvency, profitability and efficiency of the firms. The firms used for this study were selected from an annual industrial COMPUSTAT tape containing data for all December 31 fiscal year US firms for the period 1947-75. The empirical results were based on both the value- and equal-weighted indices of the selected ratios. Classification patterns of financial ratios were developed via factor analysis using indices (variables) both in the level and in the first-difference form.

The number of factors - i.e. the number of financial ratio classes - extracted was determined in the first place by a priori knowledge and interpretative aspects.

The empirical analysis showed that the resulting empirically-based classification was not fully equivalent to the a priori classification. We found the following factors: solvency, profitability, efficiency and dynamic liquidity. An interesting feature was that the short-term and long-term solvency did not differ from each other. The above mentioned result was obtained using the first differences of the value-weighted averages of the ratios. The use of the first differences of the ratios was necessary because of the very clear positive or negative trend in the time series. The use of first-differences in the analysis made it also possible to overcome the open and quite serious problem concerning the role of the constant term in financial ratio analysis. Further, the empirical analysis showed that different aggregation methods led to different results. The theoretically better value-weighted indices gave more accurate empirical results which were also more easy to interprete.

We also measured, using transformation analysis, the long-term stability of the factor patterns obtained. The resulting factor pattern - based on value-weighted averages in the first-difference form - displayed very clear time series stability. On the other hand, the results gave evidence of considerable instability between factor patterns when the variables were equal-weighted indices. These results confirmed the great importance of aggregation method in the ratio analysis. Based on the classification and stability analysis we gave some criteria how to choose the good financial ratios.

Finally, we made some demonstrations concerning the potential use of financial ratios in macro-economic analysis.

ACKNOWLEDGEMENTS

The authors wish to thank Professor Vesa Mäkinen and Dr. Erkki K. Laitinen for their valuable comments on the manuscript. The financial support from the Yrjö Jahnsson Foundation is gratefully acknowledged.

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APPENDIX 1

DEFINITION OF THE SELECTED 12 FINANCIAL RATIOS

Balance sheet

Assets

(1) Cash
(2) Marketable securities
(3) Accounting receivable
(4) Inventories
(5) Other current assets
(6) Investments and other assets
(7) Plant and equipment
(8) Total assets

Liabilities and equity

(9) Accounts payable
(10) Other current liabilities
(11) Long-term debt
(12) Deferred tax
(13) Shareholders' equity

Income statement

(14) Sales
(15) Other income
(16) Cost of good sold
(17) Excise taxes
(18) Marketing, administrative, and general expenses
(19) Interest expence

(20) Other expences
(21) Earnings before tax
(22) Tax
(23) Earnings after tax
(24) Extraordinary items
(25) Earnings after extra items

Statement of changes in financial position

Working capital provided by

(26) Net earnings
(27) Depreciation
(28) Deferred tax
(29) Extraordinary items
(30) Issue of long-term debt
(31) Other sources

Working capital used for

(32) Addition to plant and equipment
(33) Cash dividends
(34) Retirement of long-term debt
(35) Other uses

Computation of the ratios

Liquidity ratios

Current ratio:

$$CR = \frac{(1) + (2) + (3) + (4) + (5)}{(9) + (10)}$$

Quick ratio:

$$QR = \frac{(1) + (2) + (3)}{(9) + (10)}$$

Defensive interval measure:

$$DI = \frac{((1) + (2) + (3)) \times 365}{(16) + (17) + (18) + (19) + (20) - (27) - (28)}$$

Long-term solvency ratios

$$DE = \frac{(11)}{(12) + (13)}$$

Long-term debt to equity:

$$LTDE = \frac{(9) + (10) + (11)}{(12 + (13)}$$

Times interest earned:

$$TIE = \frac{(14) - ((16) + (17) + (18))}{(19)}$$

Profitability ratios

Earnings to sales:

$$ES = \frac{(25)}{(14)}$$

Return on assets:

$$ROA = \frac{(23) + (19) - .5 \times (19)}{(8)}$$

Return on equity:

$$ROE = \frac{(23)}{(12) + (13)}$$

Turnover ratios

Total assets turnover:

$$TAT = \frac{(14)}{(8)}$$

Inventory turnover:

$$IT = \frac{(14)}{(4)}$$

Accounts receivable turnover:

$$ART = \frac{(14)}{(3)}$$

APPENDIX 2

DATA MATRIX: ECONOMY-WIDE INDICES FOR 12 FINANCIAL RATIOS OVER THE PERIOD 1947 - 1975

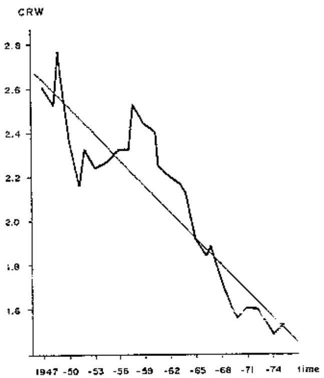
Year	Current ratio (CR)		Quick ratio (QR)		Defensive interval (DI)	
	Equal-weighted index CRE	Value-weighted index CRW	Equal-weighted index QRE	Value weighted index QRW	Equal weighted index DIE	Value-weighted index DIW
1947	3.17	2.60	1.78	1.55	108.9	105.1
1948	3.13	2.53	1.73	1.48	101.6	96.6
1949	3.73	2.76	2.15	1.72	112.0	103.3
1950	2.95	2.37	1.77	1.55	120.6	113.7
1951	2.64	2.16	1.51	1.34	108.9	104.9
1952	2.88	2.32	1.67	1.38	106.8	102.4
1953	2.98	2.23	1.70	1.39	102.0	96.6
1954	3.17	2.36	1.85	1.49	112.4	103.0
1955	2.97	2.29	1.77	1.49	113.7	107.0
1956	2.97	2.33	1.69	1.41	104.5	93.5
1957	3.06	2.34	1.68	1.39	98.2	87.9
1958	3.33	2.53	1.89	1.57	108.8	100.0
1959	3.10	2.43	1.77	1.53	106.3	100.4
1960	3.11	2.39	1.76	1.49	100.4	95.9
1961	2.82	2.25	1.75	1.49	104.2	100.6
1962	2.81	2.22	1.76	1.48	103.6	100.1
1963	2.84	2.18	1.84	1.48	103.8	101.5
1964	2.73	2.11	1.76	1.41	104.3	97.8
1965	2.55	1.91	1.64	1.29	104.8	95.4
1966	2.51	1.85	1.62	1.20	101.7	91.1
1967	2.62	1.87	1.66	1.19	103.8	90.6
1968	2.53	1.73	1.65	1.11	105.5	91.9
1969	2.32	1.61	1.47	1.02	104.5	89.0
1970	2.50	1.55	1.60	0.95	101.7	86.2
1971	2.51	1.61	1.61	1.02	103.4	87.7
1972	2.54	1.61	1.68	1.05	104.3	89.4
1973	2.26	1.57	1.43	1.03	99.8	89.4
1974	2.14	1.50	1.23	0.92	92.4	80.0
1975	2.46	1.54	1.51	0.98	95.3	80.4

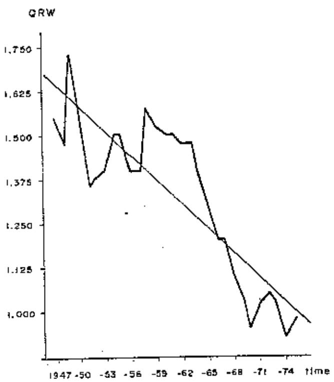
Year	Debt to equity (DE)		Long-term debt to equity (LTDE)		Times interest earned (TIE)	
	Equal-weighted index DEE	Value-weighted index DEW	Equal-weighted index LTDEE	Value weighted index LTDEW	Equal weighted index TIEE	Value-weighted index TIEW
1947	0.56	0.51	0.38	0.28	26.3	13.9
1948	0.56	0.53	0.36	0.29	25.7	15.1
1949	0.49	0.49	0.31	0.25	20.8	12.5
1950	0.58	0.53	0.41	0.32	27.2	13.2
1951	0.68	0.59	0.49	0.37	21.2	12.4
1952	0.69	0.59	0.47	0.35	18.0	10.8
1953	0.67	0.59	0.44	0.34	14.9	9.8
1954	0.61	0.54	0.39	0.30	15.5	10.9
1955	0.65	0.56	0.42	0.33	17.0	12.4
1956	0.69	0.54	0.43	0.30	14.6	8.9
1957	0.67	0.55	0.40	0.29	13.0	8.1
1958	0.72	0.52	0.40	0.25	11.1	6.7
1959	0.67	0.53	0.40	0.27	11.9	6.3
1960	0.72	0.54	0.43	0.27	9.3	5.8
1961	0.84	0.62	0.43	0.26	9.1	5.5
1962	0.86	0.63	0.44	0.26	9.4	5.3
1963	0.85	0.62	0.44	0.27	9.1	5.2
1964	0.88	0.63	0.46	0.27	9.4	4.9
1965	1.09	0.68	0.58	0.32	9.3	4.8
1966	1.06	0.73	0.56	0.33	9.5	4.7
1967	1.08	0.74	0.54	0.32	7.6	4.2
1968	1.15	0.80	0.58	0.35	7.2	3.9
1969	1.19	0.85	0.61	0.39	6.5	3.3
1970	1.25	0.92	0.65	0.41	5.5	2.9
1971	1.18	0.93	0.59	0.40	6.1	3.0
1972	1.30	0.93	0.67	0.41	7.1	3.1
1973	1.28	0.95	0.68	0.44	6.3	2.9
1974	1.31	1.02	0.70	0.50	5.7	2.6
1975	1.26	0.98	0.65	0.46	5.2	2.5

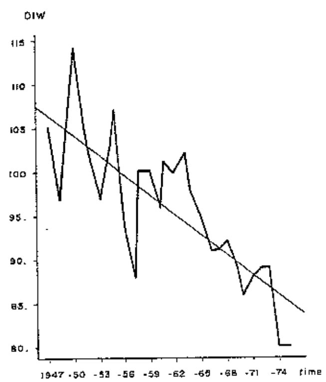
Year	Earnings to sales (ES) Equal-weighted index ESE	Earnings to sales (ES) Value-weighted index ESW	Return on assets (ROA) Equal-weighted index ROAE	Return on assets (ROA) Value weighted index ROAW	Return on equity (ROE) Equal weighted index ROEE	Return on equity (ROE) Value-weighted index ROEW
1947	0.088	0.082	0.117	0.094	0.219	0.155
1948	0.091	0.090	0.119	0.105	0.204	0.179
1949	0.082	0.082	0.098	0.088	0.163	0.146
1950	0.094	0.091	0.119	0.106	0.203	0.176
1951	0.073	0.072	0.090	0.085	0.155	0.143
1952	0.064	0.066	0.075	0.075	0.133	0.126
1953	0.064	0.064	0.077	0.077	0.131	0.130
1954	0.068	0.071	0.077	0.078	0.129	0.129
1955	0.073	0.079	0.091	0.093	0.160	0.152
1956	0.084	0.079	0.090	0.086	0.148	0.139
1957	0.079	0.075	0.076	0.075	0.130	0.127
1958	0.075	0.069	0.067	0.062	0.110	0.101
1959	0.088	0.076	0.077	0.069	0.134	0.114
1960	0.069	0.073	0.065	0.053	0.109	0.106
1961	0.069	0.072	0.057	0.050	0.123	0.102
1962	0.073	0.074	0.062	0.051	0.112	0.108
1963	0.075	0.076	0.063	0.053	0.117	0.113
1964	0.078	0.080	0.067	0.054	0.129	0.120
1965	0.083	0.082	0.073	0.056	0.148	0.128
1966	0.086	0.080	0.077	0.056	0.159	0.130
1967	0.079	0.074	0.068	0.051	0.144	0.120
1968	0.083	0.072	0.066	0.052	0.140	0.125
1969	0.068	0.067	0.062	0.048	0.138	0.120
1970	0.057	0.059	0.052	0.044	0.120	0.105
1971	0.062	0.061	0.055	0.045	0.118	0.112
1972	0.069	0.063	0.060	0.046	0.136	0.119
1973	0.070	0.068	0.066	0.053	0.184	0.140
1974	0.054	0.059	0.067	0.056	0.140	0.145
1975	0.051	0.052	0.057	0.047	0.135	0.121

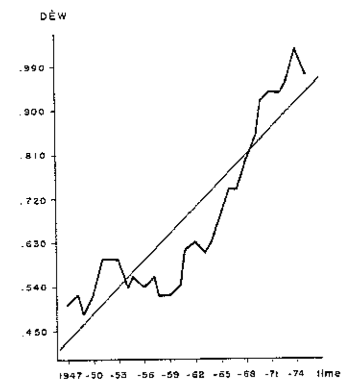
Year	Total asset turnover (TAT) Equal-weighted index TATE	Total asset turnover (TAT) Value-weighted index TATW	Inventory turnover (IT) Equal-weighted index ITE	Inventory turnover (IT) Value weighted index ITW	Accounts receivable turnover (ART) Equal weighted index ARTE	Accounts receivable turnover (ART) Value-weighted index ARTW
1947	1.55	1.10	8.47	5.60	16.05	9.53
1948	1.57	1.13	8.60	5.70	16.44	9.54
1949	1.44	1.02	8.80	5.46	15.85	8.68
1950	1.53	1.12	10.19	6.45	15.31	8.89
1951	1.54	1.15	9.71	6.26	15.04	8.65
1952	1.48	1.09	9.39	5.73	14.81	8.00
1953	1.51	1.14	9.84	6.08	15.43	8.19
1954	1.40	1.04	9.55	5.82	14.47	7.65
1955	1.49	1.13	10.68	6.64	14.03	8.10
1956	1.49	1.09	10.34	6.31	13.47	7.36
1957	1.28	0.94	9.47	6.12	13.78	7.36
1958	1.20	0.84	9.46	5.74	12.62	6.77
1959	1.23	0.87	10.11	6.32	13.05	6.98
1960	1.14	0.64	9.57	6.17	12.60	6.53
1961	1.19	0.60	10.18	6.10	12.39	6.32
1962	1.26	0.62	11.19	6.38	12.16	6.29
1963	1.24	0.62	11.55	6.51	11.71	6.09
1964	1.22	0.60	12.44	6.67	11.45	6.02
1965	1.22	0.61	12.98	6.82	10.82	6.05
1966	1.25	0.61	12.06	6.70	10.69	5.49
1967	1.18	0.60	11.45	6.47	10.33	5.56
1968	1.19	0.60	11.80	6.70	10.03	5.80
1969	1.17	0.59	12.03	6.60	9.85	5.60
1970	1.10	0.57	11.58	6.26	8.92	5.34
1971	1.09	0.56	11.10	6.35	8.82	5.44
1972	1.11	0.55	12.34	6.71	9.22	5.30
1973	1.16	0.58	12.63	7.20	9.52	5.55
1974	1.21	0.64	12.14	7.33	9.58	6.10
1975	1.15	0.61	11.26	6.71	9.39	5.78

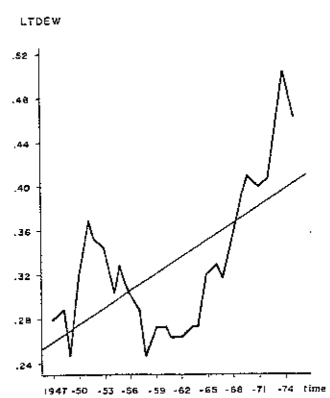
APPENDIX 3. GRAPHS OF THE TIME SERIES OF THE RATIOS

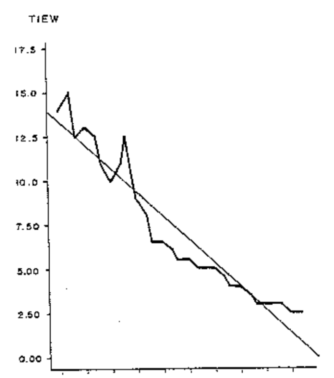


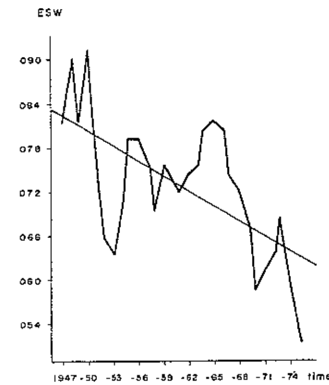


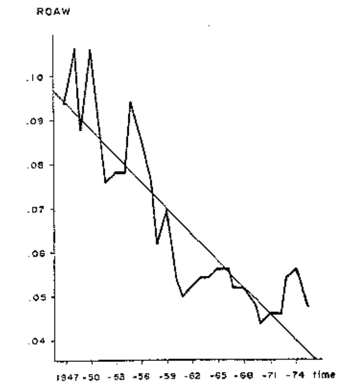


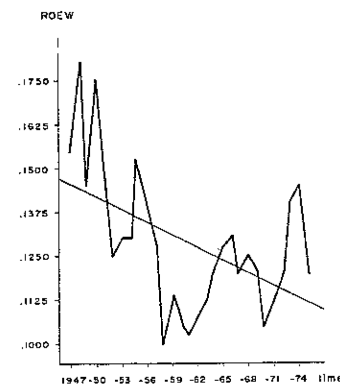


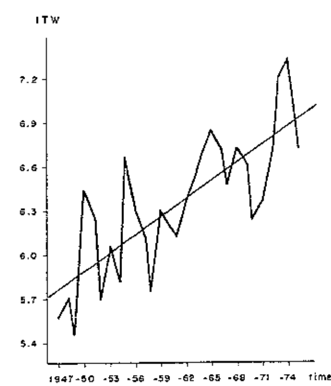


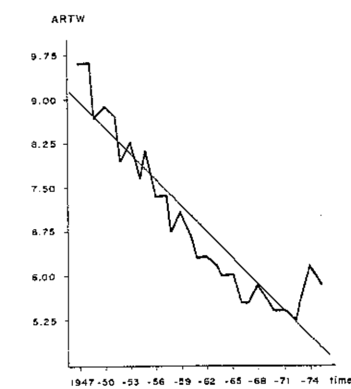












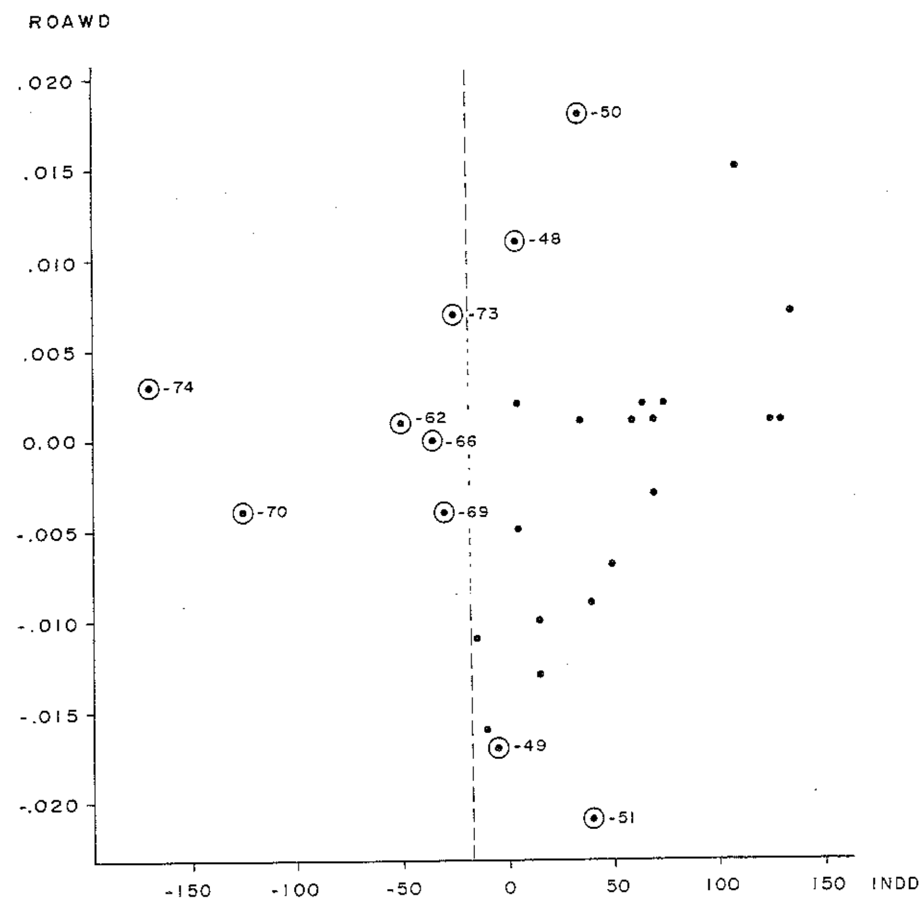
APPENDIX 4

THE AVERAGE ANNUAL US STOCK MARKET PRICE INDEX

Year	Index
1947	176
1948	180
1949	176
1950	213
1951	255
1952	270
1953	274
1954	333
1955	442
1956	491
1957	475
1958	492
1959	628
1960	618
1961	687
1962	636
1963	702
1964	832
1965	907
1966	870
1967	874
1968	907
1969	877
1970	752
1971	879
1972	949
1973	925
1974	755
1975	794

APPENDIX 5

SCATTER DIAGRAM FOR THE FIRST DIFFERENCES OF THE STOCK MARKET PRICE INDEX AND THE PROFITABILITY MEASURE ROA (ROA COMPUTED AS THE VALUE-WEIGHTED AVERAGE)



SCATTER DIAGRAM FOR THE FIRST DIFFERENCES OF THE STOCK MARKET PRICE INDEX AND THE PROFITABILITY MEASURE ROA (ROA COMPUTED AS THE EQUAL-WEIGHTED AVERAGE)