

IFORS 93

XIII World Conference on Operations Research

Lisbon – Portugal, July 12–16, 1993

THE GENERALIZED ASSOCIATION BETWEEN FINANCIAL STATEMENTS AND SECURITY CHARACTERISTICS

Salmi, Timo

Virtanen, Ilkka

Yli-Olli, Paavo

University of Vaasa
P.O. Box 297
65101 Vaasa, Finland

The Generalized Association between Financial Statements and Security Characteristics

Abstract

A strong relationship between the firms' financial ratios and their security characteristics is observed when canonical correlation analysis is applied instead of trying to measure the volatile relationships between the individual variables. It is seen from a sample of 32 firms for 1974-84 that the key ratios in the relationship differ with time. Furthermore, it is observed that accrual-based ratios relate more significantly than the cash-based ratios to the security characteristics. Cash-based ratios are incrementally significant, though. To establish a relationship between the financial ratios and the security characteristics a limited number of temporally varying key ratios is sufficient. Finally, it is observed that in assessing security characteristics the expected returns and beta are sufficient. Higher moments have no incremental significance.

The Generalized Association between Financial Statements and Security Characteristics

1. Introduction and Overview

Many studies have considered the association between a firm's financial ratios and its security characteristics measured by market-based ratios. Studies by Ball and Brown (1969), Beaver, Kettler and Scholes (1970), Gonedes (1973), Beaver and Manegold (1975), Bildersee (1975), Bowman (1979), Hill and Stone (1980), Barlev and Livnat (1986), and Ismail and Kim (1989) focus on the association between a firm's accounting beta and its security market beta. Bowman (1979) provides a theoretical analysis of a relationship between the firm's systematic risk (security market beta) and the firm's accounting beta (and leverage) while e.g. Ismail and Kim (1989) present empirical evidence on the association. These results point to a relationship between a firm's risk related to the financial variables and security characteristics which is the subject of this paper.

Beaver, Kettler and Scholes (1970), Pettit and Westerfield (1972), O'Connor (1973), Rosenberg and McKibben (1973), Hochman (1983), Martikainen (1990a, 1990b), and Kim and Lipka (1991) seek to establish which single financial ratio(s), or cluster (factor) of financial ratios best correlate with a security's return and risk. This approach implicitly assumes that the market's evaluation of a firm's performance and financial standing is based on an unvarying set of financial ratios. For example Martikainen (1990a, 1990b) uses profitability, financial leverage, operating leverage, and growth to explain in turn the firm's security price, return, and risk.

We shall extend these results by taking a more generalized approach to the question of the association. Our first question is whether there is a general correlation between financial ratios and security characteristics. To tackle this question we apply canonical correlation analysis on a cross section of (accrual-based and cash-based) financial ratios and security information of 32 publicly traded Finnish companies for 1974-84. Our results confirm that security return and risk are strongly associated to financial ratios, but that the set of best predicting financial ratios is not constant.

Wilson (1986, 1987), Bowen, Burgstahler and Daley (1987), Bliann and Balachandran (1988), Kinnunen (1988), Bernard and Stober (1989), Ismail and Kim (1989), Ou and Penman (1989), Sudarsanam and Fortune (1989), Livnat and Zarowin (1990), Niskanen

(1990), among others, have investigated whether cash-based financial ratios behave differently from accrual-based financial ratios, and whether they contain more relevant information for security investment decisions than the accrual-based figures. The general contention in these studies has been that cash-flows have significant incremental information for the decision maker. For example Ismail and Kim (1989) came to the conclusion that cash-flow data has the potential of supplying additional information on a firm's risk beyond that available from earnings. These results give rise to our second research question whether the cash-based financial ratios or the accrual-based financial ratios have a stronger relation with security characteristics. Our results do not corroborate a view that the cash-flow information would have more relevance than the accrual-based figures (rather vice versa).

A consequent question invoked by the above result and the earlier research is whether the cash-based information still is incrementally significant for a relationship between financial ratios and security characteristics. Our empirical results do not corroborate the view that the cash-flows impart decisive incremental information for security evaluation.

It is commonly believed that investors use only a few key factors in their evaluation of a firm's performance and financial standing. Our third major research question is whether the generalized association between the financial ratios and the security characteristics still holds for a reduced set of accrual-based financial ratios. Our empirical results conform to the view of a few key factors being sufficient. The adjusted strength of the observed correlation between the reduced set and the security characteristics is over par with the non-reduced set of financial ratios.

Pinches, Mingo and Caruthers (1973), Pinches, Eubank, Mingo and Caruthers (1975), Laurent (1979), Johnson (1979), Aho (1980), Chen and Shimerda (1981), Pohlman and Hollinger (1981), Cowen and Hoffer (1982), Yli-Olli and Virtanen (1985), Ezzamel, Brodie and Mar-Molinero (1987), Salmi, Virtanen and Yli-Olli (1990), Kanto and Martikainen (1991), and Luoma and Ruuhela (1991) represent a strong tradition of research in financial statement analysis striving to reduce a (large) number of financial ratios into a smaller number of mutually exclusive categories covering the various aspects of the firm's activities. These studies have typically used factor analysis methods. The implication for our study is that the information content of the financial ratios is portrayed by a limited set of key ratios, and we shall consequently look into the correlation between this set and the security characteristics.

Fama and MacBeth (1973, 1974), and Roll (1977) indicate that, in the Security Market Line (SML) form of Capital Asset Pricing Model, two parameters of returns, i.e. mean and beta-risk, are the sufficient statistics to define the properties of a security. This means

that according to CAPM the higher moments of the returns may not be relevant to the decision maker. Thus, our fourth research question is whether the observed expected returns and betas are adequate, or whether the empirical relation between financial ratios and security characteristics is strengthened by the inclusion of the higher moments of security returns. Our empirical results indicate that inclusion of the higher moments does not strengthen the empirical association, and thus corroborate the SML form of CAPM.

2. Research Hypotheses

We test four sets of research hypotheses concerning the association between financial ratios and market-based ratios. Our first pair of hypotheses relates to the potential association between a firm's financial characteristics as expressed in its financial ratios (accounting-based information) and its securities' characteristics (market-based information). If an association is observed, this corroborates a view that financial ratio analysis can be a useful part of security analysis.

As discussed in the introduction, previous studies have sought for stable relationships between security characteristics and particular financial ratios, or financial ratio factors. Looking at particular financial ratios is, however, a limiting precondition, and we formulate our first hypothesis for more general association, and use a more generic statistical methodology (canonical correlation analysis). Thus, we test the following null hypothesis:

- 1a) There is no canonical correlation between firms' accrual-based and cash-based financial ratios, and the security characteristics.

If the empirical evidence refutes the null hypothesis 1a), i.e. the evidence suggests that there is an association, we will test null hypothesis 1b):

- 1b) The observed correlation in 1a) is not intertemporally stable.

The relative usefulness of alternative accounting information bases has been much discussed. In particular, much interest has focused on the question whether accrual-based or cash-based accounting produces more relevant information for security analysis. Two somewhat incompatible doctrines on cash-based figures should be noted here. In the theory of finance (capital investments more particularly) the focus of interest is on the value of the firm (and consequently the security behavior) which is considered to be the present value of the firm's all future cash-flows. On the other hand, the more pragmatic financial accounting has a different focus of interest. Foremost, this alternative doctrine

sees cash-flow and funds-flow information as supplemental information to historical accrual-based financial statements in annual disclosure. Because of this practical aspect, the observable cash-flow information has this supplemental nature in financial ratio analysis, rather than being a self-contained alternative information set. For this reason, we test the following set of three null hypotheses:

- 2a) Neither the accrual-based nor cash-based ratios, when taken separately, have a correlation with the security characteristics.
- 2b) If the correlations exist then the cash-based figures and accrual-based figures correlate equally with the security characteristics.
- 2c) If there is a difference, the less significant set (cash-based / accrual-based) gives no incremental correlation information.

It is typical of the human decision making process, that the decision maker seeks to reduce the influx of information into a few key elements or figures. This quest for keeping information in manageable proportions and concentrating on what is deemed essential gives rise to our next research hypothesis which is used to test the view that investors use only a few key ratios.

- 3) A reduced set of financial ratios essentially has the same correlation with security characteristics as a non-reduced one.

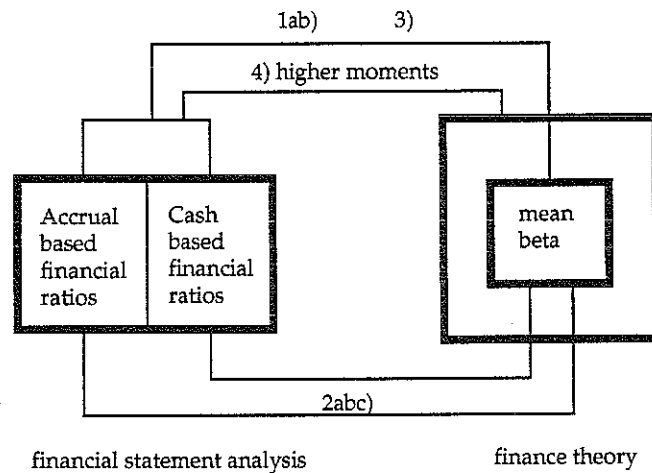
Finally, we can examine if the standard CAPM is a sufficient description of the market return. If the standard CAPM is the best description of the general equilibrium then the higher moments should have no influence on the market return. In accordance to this view the mean and beta of security returns would be sufficient surrogates of security characteristics. Thus we test the following null hypothesis.

- 4) The correlation between the financial ratios and the security characteristics is not strengthened by the inclusion of variance, skewness, and kurtosis of security returns.

The following Figure 1 illustrates the potential associations.

Figure 1.

The illustration of the research hypotheses



3. Data and Methodology Description

Our full set of the accrual-based financial ratios is the same as used in Foster (1978, p. 60), which has been used in many studies. The ratios are listed in Appendix 1A (variables x_1 - x_{12}). The definitions for calculating these basic ratios are given in Yli-Olli (1983, pp. 62-65). For a discussion see Yli-Olli and Virtanen (1985, pp. 11-13). The full set of the cash-based financial ratios follow Gombola and Ketz (1983). The ratios are listed in Appendix 1A (variables x_{13} - x_{20}).

The ratios were obtained for cross sections of 32 publicly traded Finnish companies for 1974-84. See Salmi, Virtanen and Yli-Olli (1990, Appendix G) for the list of the firms which we included in the analysis.

The period was not extended beyond 1984 for several reasons. The 1974-84 period was stable in the Finnish economy, while the 1985-88 period experienced a serious overheating resulting in excessively high share prices. From 1989 there has been an exceptionally steep decline in the Finnish stock market and in the Finnish economy. Fortunately, the selection of the time period is not critical in our study because we are

interested in a generic relationship rather than a particular time period.

The security characteristics used, i.e. the return and beta, and the variance, skewness and kurtosis of return series, were calculated from the weekly stock returns for the same group of 32 companies. The annual values are thus based on 52 observations each.

To obtain the values of the variables (both financial ratios and security characteristics) for our study period (1974-84) and subperiods (1974-78, 1979-84) we applied simple arithmetic averages of the annual data.

This grouping (averaging) of ratios was needed to make the originally three dimensional data (the variables, cross-sectional variation, intertemporal variation) two dimensional. This means, of course, some loss of information but it must be done for the correlation analysis. Contrary to regression analysis, correlation analysis (including the generalized canonical correlations) does not have any dummy variable or related technique to handle this type of interdependencies in the data. In addition, the annual fluctuations of the ratios would be so high that any pattern of correlation would be hidden by the two dimensional (years, firms) residual variation. Therefore, the annual variation was averaged out before the standard analysis. The method of subdividing the basic period into two subperiods was used to study the intertemporal stability of the correlation pattern obtained.

The individual asset returns were collected from a data base originally introduced by Berglund, Wahlroos and Grandell (1983). The price indices used for calculating the returns were the closing values for each Wednesday. The prices were corrected for splits, new issues etc. assuming that dividends were reinvested with zero transaction cost. The returns for each week were calculated as first differences of the natural logarithms of these price indices. The general index in use (when calculating the betas) was the value-weighted market index collected from the same data base. The annual beta coefficients were calculated using Sharpe's market model with weekly returns.

For studying the association between the two sets of variables, i.e. financial ratios and security characteristics, we applied canonical correlation analysis. See for example Green (1978, pp.260-289) for the statistical foundations of the canonical correlation analysis, and Fornell and Larcker (1980) and Pohiman and Hollinger (1981) for its applications in accounting research.

Canonical correlation analysis is a more general case of the usual multiple regression analysis. In the case of multiple regression the aim is to find a linear combination of the independent (or predictor) variables such that the composite has the maximum correlation with the dependent (or criterion) variable. In canonical correlation the interest centers on

the linear association between one battery of variables, the predictor variables x_1, x_2, \dots, x_p , and another battery of variables, the criterion variables y_1, y_2, \dots, y_q .

The objective in canonical correlation analysis is to find a linear composite of the x_i -variables, $i=1, 2, \dots, p$, and a (different) linear composite of the y_j -variables, $j=1, 2, \dots, q$, such that when this pair of derived variables (linear composites) is correlated, the resulting (usual) bivariate correlation is the highest attainable.

Having done this, it is (generally) possible to find a second pair of linear composites, chosen to be uncorrelated with the first pair, such that the correlation between this second pair of derived variables is, conditionally for the first pair, maximal. In general, with p predictors and q criteria we can obtain $r = \min(p, q)$ different pairs of linear composites. The correlations between successive pairs will, in general decline in size.

4. Empirical Results and Interpretation

Appendix 5 provides the tables summarizing the basic statistics of the variables for the entire period, and the subperiods 1974-78 and 1979-84.

First the association between all the financial ratios (the twelve averaged accrual-based ratios and the eight averaged cash-based ratios) and the CAPM security characteristics (the average return and beta) was studied for the entire 1974-84 period. The relevant empirical results of the canonical correlation analysis are in condensed form in Appendix 1A. The (first) canonical correlation between the financial ratios and security characteristics is 0.925, and the correlation is significant (0.0267) at the 5 per cent risk level. Thus the conclusion about our first hypothesis (1a) is that there is a significant association between financial ratios and security characteristics.

Our next hypothesis (1b) concerned the stability of the correlation. The results in Appendixes 1B-1 and 1B-2 for the subperiods of 1974-1978 and 1979-84, respectively, give reasonable support to a general stability. But although numerically high, the association is not strictly significant (0.0734) at the 5 per cent risk level for the 1974-78 period.

By comparing the standardized canonical coefficients for the individual variables a very interesting observation can be made. Although there is a general association between the financial ratios and security characteristics, the individually significant variables are not stable. In layman's terms this means that although it can be stated that financial ratio analysis is important for security analysis, a mechanistic analysis involving an invariance

set of predetermined variables cannot be presaged. This volatility of the key ratios is also in line with the frequented view in literature which points out the fact that the last factors resulting from factoring financial ratios fluctuate widely from one study to another.

Note that observing a strong association between financial ratios and security characteristics is not tantamount to claiming that abnormal returns can be earned by applying an analysis of financial ratios. This is not a CAR (cumulative abnormal returns) study.

Our second set of hypotheses (2abc) concerned the relevance of the accrual-based versus cash-based financial ratios in relation to security characteristics. From Appendixes 2AB-A (the last A stands for accrual-based) and 2AB-C (C for cash-based) it is seen that both financial ratio sets are significantly correlated with security characteristics, but that the strength of the correlation is clearly lower for the cash-based ratios. Note that this does not, per se, indicate that cash-flow information is less relevant for security analysis than accrual-based financial ratios. But what it does indicate is that cash-based financial ratios when calculated as suggested in standard literature are not up to the standard of accrual-based financial ratios. One clear conclusion is that the traditional definitions of cash-based financial ratios need a serious reevaluation. On the other hand comparing the results of Appendix 1A and 2AB-A indicates that the cash-based figures have incremental informational value for security analysis (Hypothesis 2c).

Our third hypothesis (3) concerned whether a limited set of key financial ratios is sufficient for security analysis. Appendix 3-A gives the results for a reduced set of accrual-based ratios: quick ratio, debt to equity, return on equity, total assets turnover, and defensive interval measure. The selection of these five ratios was based on the classifications in Foster (1978), Lev (1974), Yli-Olli and Virtanen (1985), Salmi, Virtanen and Yli-Olli (1990), and our deliberations. The reduced set of financial ratios represents the following categories: Liquidity, Solvency, Profitability, Turnover, and Dynamic Liquidity (see Yli-Olli and Virtanen (1985) for the inclusion of the defensive interval measure to represent dynamic liquidity). The correlation with security characteristics remains strong and highly significant for the reduced set of accrual-based financial ratios.

Likewise, the cash-based financial ratios from Gombola and Ketz (1983) were reduced into cash/sales and cash-flow/equity, since these two can best be expected to be independent by definition. This reduction does not retain a significant association between cash-based financial ratios and security characteristics. This need not be indicative of a poor usefulness of cash-based information. Rather it may be indicative of a fact that the cash-based financial ratios have been inadequately defined in earlier literature.

Looking more fully into this aspect remains a subject for further research.

Our last hypothesis (4) was concerned whether including unsystematic risk, and the higher moments (skewness and kurtosis) of the returns of individual securities makes the empirical association stronger between the financial ratios and security characteristics. This is an interesting question because the theory of the standard Capital Asset Pricing Model assumes normality of the returns (and thus no need for the higher moments), and also assumes that all relevant riskiness is reflected in the beta (systematic risk). On the basis of the results of testing the previous hypotheses we look into this association using the reduced set of accrual-based financial ratios. The results in Appendixes 4 and 4-H (H for higher moments) indicate that the higher moments have no incremental influence on the strength of the canonical correlation coefficients. The insignificance of the higher moments has interesting implications on the empirical relevance of the Capital Asset Pricing Model. This corroborates that the standard CAPM model is a sufficient description of the market returns.

5. Summary

Our results corroborate the view that for an investor a select set of accrual-based financial ratios contains essential information for security assessment, and that there is very much redundancy in the financial ratios. This is in line with the observation that beyond five key ratios, the results of studies categorizing financial ratios have given no consistent patterns but have varied from study to study. Our results also corroborate that a simple mechanistic analysis is not sufficient for investment decisions, since the weights of the key ratios vary significantly over time.

Our results cast doubt on the method ordinarily used for defining cash-based financial ratios in the restricted manner exemplified by Gombola and Ketz (1983). It remains a subject of further research to see if defining cash-based financial ratios in a way that would make them true alternative counterparts of accrual-based figures would add useful incremental information for security analysis.

Our results also show that measuring security characteristics with return and beta is sufficient in the sense that the unsystematic risk (variance) and the higher moments (skewness and kurtosis) of the returns of individual securities have no significant incremental information value for observing relationships between financial statement variables and security characteristics. The empirical results are thus in agreement with the Capital Asset Pricing Model.

References

- Aho, T. (1980), "Empirical Classification of Financial Ratios" in *Management Science in Finland (MASC 1980) Proceedings*, Christer Carlsson, ed. (1980), pp. 413-421.
- Ball, R. and P. Brown (1969), "Portfolio Theory and Accounting", *Journal of Accounting Research* (1969), pp. 300-323.
- Barlev, B. and J. Livnat (1986), "The Statement of Financial Position: Its Relationship with security prices", *Journal of Business Finance and Accounting*, Vol.13 (1986), pp. 223-238.
- Beaver, W. H., P. Kettler and M. Scholes (1970), "The Association Between Market-Determined and Accounting-Determined Risk Measures", *The Accounting Review* (1970), pp. 654-682.
- Beaver, W.H. and J. Manegold (1975), "The Association Between Market-Determined and Accounting-Determined Measures of Systematic Risk: Some Further Evidence", *Journal of Financial and Quantitative Analysis* (1975), pp. 231-284.
- Berglund, T., B. Wahlroos and L. Grandell (1983), "KOP:s och UNITAS generalindex för Helsingfors fondbörs i ljuset av ett nytt värdevägt index", *The Finnish Journal of Business Economics*, Vol. 32 (1983), pp. 30-41.
- Bernard, V.L. and T.L. Stober (1989), "The Nature and Amount of Information in Cash Flows and Accruals", *The Accounting Review*, Vol. 64 (1989), pp. 624-652.
- Bildersee, J.S.(1975), "The Association Between a Market-Determined Measure of Risk and Alternative Measures of Risk", *The Accounting Review*, Vol. 50 (1975), pp. 81-98.
- Blann, J. and B.V. Balachandran (1988)., "An Empirical Test of the Statistical Association of Market Risk and Financial Accounting Allocation", *Journal of Business Finance & Accounting*, Vol. 15 (1988), pp. 101-113.
- Bowen, R.M., D. Burgstahler and L.A. Daley (1987), "The Incremental Information Content of Accrual Versus Cash Flows", *The Accounting Review*, Vol. 62 (1987), pp. 723-747.
- Bowman, R.G. (1979), "The Theoretical Relation Between Systematic Risk and Financial (Accounting) Variables", *The Journal of Finance*, Vol. 34 (1979), pp. 617-630 .
- Chen, K.H. and T.A. Shimerda (1981), "An Empirical Analysis of Useful Financial Ratios", *Financial Management* (1981), pp. 51-60.
- Cowen, S.S. and J.A. Hoffer (1982), "Usefulness of Financial Ratios in a Single Industry", *Journal of Business Research*, Vol. 10 (1982), pp. 103-118.
- Ezzamel, M., J. Brodie and C. Mar-Molinero (1987), "Financial Patterns of UK Manufacturing Companies", *Journal of Business Finance & Accounting*, Vol. 14 (1987), pp. 519-536.

- Fama, E.F. and J.D. MacBeth (1973), "Risk, Return, and Equilibrium: Empirical Tests", *Journal of Political Economy*, Vol. 81 (1973), pp. 607-636.
- Fama, E.F. and J.D. MacBeth (1974), "Tests of the Multiperiod Two-Parameter Model", *Journal of Financial Economics*, Vol. 1 (1974), pp. 43-66.
- Fornell, C. and D.F. Larcker (1980), "The Use of Canonical Correlation Analysis in Accounting Research", *Journal of Business Finance & Accounting*, Vol. 7 (1980), pp. 455-473.
- Foster, G. (1978), *Financial Statement Analysis* (Prentice Hall, Inc., 1978).
- Gombola, M.J. and J.E. Ketz (1983), "A Note on Cash Flow and Classification Patterns of Financial Ratios", *The Accounting Review*, Vol. 58 (1983), pp. 105-114.
- Gonedes, N.J. (1973), "Evidence on the Information Content of Accounting Numbers: Accounting-Based and Market-Based Estimates of Systematic Risk", *Journal of Financial and Quantitative Analysis* (1973), pp. 407-443.
- Green, P.E. (1978), *Analyzing Multivariate Data*. (The Dryden Press, 1978).
- Hill, N.C. and B.K. Stone (1980), "Accounting Betas, Systematic Operating Risk, and Financial Leverage: A Risk-Composition Approach to the Determinants of Systematic Risk", *Journal of Financial and Quantitative Analysis*, Vol. 15 (1980), pp. 595-637.
- Hochman, S. (1983), "The Beta Coefficient: An Instrumental Variables Approach", *Research in Finance*, Vol. 4 (1983), pp. 128-151.
- Ismail, B. E. and M.K. Kim (1989), "On the Association of Cash-Flow Variables with Market Risk: Further Evidence", *Accounting Review*, Vol. 64 (1989), pp. 125-136.
- Johnson, B. (1979), "The Cross-Sectional Stability of Financial Ratio Patterns", *Journal of Financial and Quantitative Analysis*, Vol. 14 (1979), pp. 1035-1049.
- Kanto, A. and T. Martikainen (1991), "A Confirmatory Test of an a priori Classification Pattern of Financial Ratios: Empirical Evidence with U.S. Data", *The Finnish Journal of Business Economics*, Vol. 40 (1991), pp. 22-38.
- Kim, J.-B. and R. Lipka (1991), "Effects of Accounting Choice on the Explanation of the Market Risk in the Oil and Gas Industry", *Journal of Business Finance & Accounting*, Vol. 18 (1991), pp. 61-84.
- Kinnunen, J. (1988), "The Time Series Properties of Accrual Versus Cash-Based Income Variables: Empirical Evidence from Listed Finnish Firms", *Proceedings of the Helsinki School of Economics A-58* (1988), The Helsinki School of Economics.
- Laurent, C.R. (1979), "Improving the Efficiency and Effectiveness of Financial Ratio Analysis", *Journal of Business Finance & Accounting*, Vol. 6 (1979), pp. 401-413.
- Livnat, J. and P. Zarowin (1990), "The Incremental Information Content of Cash-Flow Components", *Journal of Accounting and Economics*, Vol. 13 (1990), pp. 25-46.

- Luoma, M. and R. Ruuhela (1991), "Consistency and Comovement of Financial Ratios: A Firm-Specific Approach", *The Finnish Journal of Business Economics*, Vol. 40 (1991), pp. 39-49.
- Martikainen, T. (1990a), "The Individual and Incremental Significance of the Economic Determinants of Stock Returns and Systematic Risk", *Acta Wasaensia* 24 (1990), University of Vaasa.
- Martikainen, T. (1990b), "Modelling Stock Price Behavior by Financial Ratios", *Rivista di matematica per le scienze economiche e sociali*, Vol. 11 (1990), 119-138.
- Niskanen, J. (1990), "On the Information Content of Accrual-Based and Cash-Based Accounting Income Numbers: Their Ability to Predict Investment Risk", *Acta Oeconomicae Helsinkiensis A* 69 (1990), The Helsinki School of Economics.
- O'Connor, M.C. (1973), "On the Usefulness of Financial Ratios to Investors in Common Stock", *The Accounting Review* (1973), pp. 339-352.
- Ou, J.A. and S.H. Penman (1989), "Financial Statement Analysis and the Prediction of Stock Returns", *Journal of Accounting and Economics*, Vol. 11 (1989), pp. 295-329 (1989).
- Pettit, R. R. and R. Westerfield (1972), "A Model of Capital Asset Risk", *Journal of Financial and Quantitative Analysis* (1972), pp. 1649-1677.
- Pinches, G.E., A.A. Eubank, K.A. Mingo and J.K. Caruthers (1975), "The Hierarchical Classification of Financial Ratios", *Journal of Business Research*, Vol. 3 (1975), pp. 295-310.
- Pinches, G.E., K.A. Mingo and J.K. Caruthers (1973), "The Stability of Financial Patterns in Industrial Organizations", *Journal of Finance*, Vol. 28 (1973), pp. 389-396.
- Pohlman, R.A. and R.D. Hollinger (1981), "Information Redundancy in Sets of Financial Ratios", *Journal of Business Finance & Accounting*, Vol. 8 (1981), pp. 511-528.
- Roll, R. (1977), "A Critique of the Asset Pricing Theory's Tests; Part I: On Past and Potential Testability of the Theory", *Journal of Financial Economics*, Vol. 4 (1977), pp. 129-176.
- Rosenberg, B. and W. McKibben (1973), "The Prediction of Systematic and Specific Risk in Common Stocks", *Journal of Financial and Quantitative Analysis* (1973), pp. 317-334.
- Salmi, T., I. Virtanen and P. Yli-Olli (1990), "On the Classification of Financial Ratios: A Factor and Transformation Analysis of Accrual, Cash Flow, and Market-Based Ratios", *Acta Wasaensia* 25 (1990), University of Vaasa.
- Sudarsanam, P. S. and L.H. Fortune (1989), "Relative Usefulness of Accrual-Based and Cashflow-Based Earnings in Security Evaluation: An Empirical Test. Paper presented to the Annual Conference of the European Accounting Association at the University of Stuttgart, West Germany from the 5th to the 7th of April 1989.

- Wilson, G.P. (1986), "The Relative Information Content of Accruals and Cash Flows: Combined Evidence at the Earnings Announcement and Annual Report Release Date", *Journal of Accounting Research*, Vol. 24 (Supplement 1986), pp. 165-199.
- Wilson, G.P. (1987), "The Incremental Information Content of the Accrual and Funds Components of Earnings After Controlling for Earnings", *The Accounting Review*, Vol. 62 (1987), pp. 293-322.
- Yli-Olli, P. (1983), Tilinpäätösanalyysissä käytettävien tunnuslukujen luokittelu ja stabiilisuus. (Summary: The empirical classification of financial ratios and the stability of the classification.) *Proceedings of the University of Vaasa. Research Papers* 95 (1983), University of Vaasa.
- Yli-Olli, P. and I. Virtanen (1985), Modelling a financial ratio system on the economy-wide level. *Acta Wasaensia* 21 (1985), University of Vaasa.

APPENDIX 1A: Canonical Correlation Analysis: Return and Beta vs All Financial Ratios, 1974-84.

Canonical Variables	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error
1	0.925436	0.871041	0.025786
2	0.878130	0.816609	0.041109

Test of H0: The canonical correlations in the current row and all that follow are zero:

Canonical Correlations	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.03286104	2.2582	40	20	0.0267
2	0.22888755	1.9504	19	11	0.1285

Standardized Canonical Coefficients for the 'VAR' Variables

	V ₁	V ₂	
x ₂₁	0.5977	-0.8720	securitys beta
x ₂₂	1.0188	0.2824	return on the security

Standardized Canonical Coefficients for the 'WITH' Variables

	W ₁	W ₂	
x ₁	-0.9443	0.8202	CR current ratio
x ₂	0.4790	-1.0013	QR quick ratio
x ₃	-1.0155	1.5236	DI defensive interval measure
x ₄	0.8400	-1.6204	DE debt to equity
x ₅	-0.5891	1.6035	LTDE long-term debt to equity
x ₆	-0.1632	-0.6722	TIE times interest earned
x ₇	2.2311	-0.1471	ES earnings to sales
x ₈	-0.4720	0.2433	ROA return on assets
x ₉	-0.4828	-0.2239	ROE return on equity
x ₁₀	0.4481	0.8136	TAT total assets turnover
x ₁₁	-0.0310	0.8978	IT inventory turnover
x ₁₂	-0.5302	0.2356	ART accounts receivable turnover
x ₁₃	1.4749	-0.9754	cash / current debt
x ₁₄	0.2265	-1.0724	cash / sales
x ₁₅	0.2827	0.4225	cash / total assets
x ₁₆	-1.7063	0.9973	cash / total debt
x ₁₇	0.3433	1.1319	cash-flow / equity
x ₁₈	-1.6146	-0.1486	cash-flow / sales
x ₁₉	-0.6270	-2.4556	cash-flow / total assets
x ₂₀	1.4239	1.9431	cash-flow / total debt

APPENDIX 1B-1: Canonical Correlation Analysis: Return and Beta vs All Financial Ratios, 1974-78.

Canonical Variables	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error
1	0.941106	0.902720	0.020533
2	0.773969	0.632559	0.072017

Test of H0: The canonical correlations in the current row and all that follow are zero:

Canonical Correlations	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.04583921	1.8353	40	20	0.0734
2	0.40097224	0.8649	19	11	0.6240

Standardized Canonical Coefficients for the 'VAR' Variables

	V ₁	V ₂	
x ₂₁	-0.0581	1.1231	securitys beta
x ₂₂	0.9721	0.5656	return on the security

Standardized Canonical Coefficients for the 'WITH' Variables

	W1	W2	
x ₁	0.2209	-0.8296	CR current ratio
x ₂	-0.7815	0.2700	QR quick ratio
x ₃	1.0473	-0.1408	DI defensive interval measure
x ₄	-1.1840	-0.7851	DE debt to equity
x ₅	1.4052	1.1925	LTDE long-term debt to equity
x ₆	0.2982	0.7263	TIE times interest earned
x ₇	1.7236	2.0263	ES earnings to sales
x ₈	-0.8278	-0.7678	ROA return on assets
x ₉	-1.1230	-1.3004	ROE return on equity
x ₁₀	1.2473	0.9037	TAT total assets turnover
x ₁₁	0.1735	-1.3025	IT inventory turnover
x ₁₂	0.1489	0.1655	ART accounts receivable turnover
x ₁₃	-0.3420	-0.0647	cash / current debt
x ₁₄	-0.5204	0.5392	cash / sales
x ₁₅	-0.2844	-0.1642	cash / total assets
x ₁₆	0.9298	-0.1418	cash / total debt
x ₁₇	1.2959	0.1214	cash-flow / equity
x ₁₈	-0.9510	0.9857	cash-flow / sales
x ₁₉	-0.9573	0.6165	cash-flow / total assets
x ₂₀	1.1367	-1.1996	cash-flow / total debt

APPENDIX 1B-2: Canonical Correlation Analysis: Return and Beta vs All Financial Ratios, 1979-84.

Canonical Variables	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error
1	0.939898	0.899639	0.020941
2	0.846767	0.759023	0.050826

Test of H0: The canonical correlations in the current row and all that follow are zero:

Canonical Correlations	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.03299409	2.2527	40	20	0.0271
2	0.28298632	1.4669	19	11	0.2607

Standardized Canonical Coefficients for the 'VAR' Variables

	V ₁	V ₂	
x ₂₁	0.9868	-0.1731	securitys beta
x ₂₂	0.1122	0.9956	return on the security

Standardized Canonical Coefficients for the 'WITH' Variables

	W1	W2	
x ₁	-1.7278	0.3721	CR current ratio
x ₂	1.6441	-0.8693	QR quick ratio
x ₃	-2.0943	1.6103	DI defensive interval measure
x ₄	3.8069	-1.4121	DE debt to equity
x ₅	-3.6131	1.3095	LTDE long-term debt to equity
x ₆	0.2911	1.8654	TIE times interest earned
x ₇	2.2436	-1.5714	ES earnings to sales
x ₈	-0.8038	-0.0426	ROA return on assets
x ₉	-0.4235	0.7843	ROE return on equity
x ₁₀	-0.2720	0.4113	TAT total assets turnover
x ₁₁	-0.6569	-0.4627	IT inventory turnover
x ₁₂	-0.6977	-0.0756	ART accounts receivable turnover
x ₁₃	3.3570	-0.4769	cash / current debt
x ₁₄	0.2746	0.0467	cash / sales
x ₁₅	0.8462	-2.7652	cash / total assets
x ₁₆	-3.5025	3.1197	cash / total debt
x ₁₇	-0.8130	-0.5471	cash-flow / equity
x ₁₈	-0.9144	0.7846	cash-flow / sales
x ₁₉	1.3749	5.3810	cash-flow / total assets
x ₂₀	-0.5648	-5.7705	cash-flow / total debt

APPENDIX 2AB-A: Canonical Correlation Analysis: Return and Beta vs Accrual-Based Financial Ratios, 1974-84.

Canonical Variables	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error
1	0.866683	0.808304	0.044697
2	0.741299	0.661968	0.080908

Test of H0: The canonical correlations in the current row and all that follow are zero:

Canonical Correlations	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.11210552	2.9800	24	36	0.0015
2	0.45047593	2.1071	11	19	0.0741

APPENDIX 2AB-C: Canonical Correlation Analysis: Return and Beta vs Cash-Based Financial Ratios, 1974-84.

Canonical Variables	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error
1	0.686371	0.559448	0.094992
2	0.581293	0.526569	0.118916

Test of H0: The canonical correlations in the current row and all that follow are zero:

Canonical Correlations	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.35018084	1.8971	16	44	0.0475
2	0.66209876	1.6769	7	23	0.1645

APPENDIX 3-A: Canonical Correlation Analysis: Return and Beta vs Reduced set of Accrual-Based Financial Ratios, 1974-84.

Canonical Variables	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error
1	0.802959	0.765538	0.063806
2	0.598566	0.568252	0.115256

Test of H0: The canonical correlations in the current row and all that follow are zero:

Canonical Correlations	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.22797542	5.4719	10	50	0.0001
2	0.64171921	3.6290	4	26	0.0177

APPENDIX 3-C: Canonical Correlation Analysis: Return and Beta vs Reduced set of Cash-Based Financial Ratios, 1974-84.

Canonical Variables	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error
1	0.412231	0.320204	0.149084
2	0.253024	.	0.168107

Test of H0: The canonical correlations in the current row and all that follow are zero:

Canonical Correlations	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.77692414	1.8832	4	56	0.1261
2	0.93597906	1.9836	1	29	0.1696

APPENDIX 4: Canonical Correlation Analysis: Return, Beta and Variance vs Reduced set of Accrual-Based Financial Ratios, 1974-84.

Canonical Variables	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error
1	0.809226	0.766023	0.061991
2	0.610870	0.564879	0.112583
3	0.137028	-.081771	0.176233

Test of H0: The canonical correlations in the current row and all that follow are zero:

Canonical Correlations	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.21229309	3.3467	15	66.65483	0.0003
2	0.61506817	1.7193	8	50	0.1170
3	0.98122345	0.1658	3	26	0.9184

APPENDIX 4-H: Canonical Correlation Analysis: Return, Beta, Variance, Skewness and Kurtosis vs Reduced set of Accrual-Based Financial Ratios, 1974-84.

Canonical Variables	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error
1	0.815855	0.758423	0.060057
2	0.659407	0.596424	0.101510
3	0.222193	-.237733	0.170759
4	0.164251	.	0.174760
5	0.108474	.	0.177492

Test of H0: The canonical correlations in the current row and all that follow are zero:

Canonical Correlations	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.17277326	2.0115	25	83.2283	0.0097
2	0.51669635	1.0692	16	70.90379	0.3999
3	0.91421079	0.2443	9	58.5603	0.9861
4	0.96157247	0.2473	4	50	0.9099
5	0.98823330	0.3096	1	26	0.5827

APPENDIX 5: Basic statistics of the variables.

The entire research period 1974-1984:

Variable	Mean	Std Dev	Variance	Skewness	Kurtosis
x1 CR current ratio	1.683	0.562	0.316	2.035	6.200
x2 QR quick ratio	0.933	0.399	0.159	1.137	2.394
x3 DI defensive interval measure	100.298	37.979	1442.389	0.826	0.949
x4 DE debt to equity	3.236	2.026	4.105	2.625	9.042
x5 LTDE long-term debt to equity	1.618	1.377	1.896	1.940	4.433
x6 TIE times interest earned	2.092	1.259	1.585	2.615	9.299
x7 ES earnings to sales	0.020	0.020	0.000	0.477	1.115
x8 ROA return on assets	0.102	0.027	0.001	0.998	0.917
x9 ROE return on equity	0.084	0.068	0.005	-0.589	0.804
x10 TAT total assets turnover	1.294	0.737	0.543	1.795	2.647
x11 IT inventory turnover	5.603	7.933	62.930	5.038	27.015
x12 ART accounts receivable turnover	8.438	3.953	15.625	1.266	2.003
x13 cash / current debt	0.079	0.057	0.003	1.062	0.521
x14 cash / sales	0.027	0.017	0.000	0.592	-0.284
x15 cash / total assets	0.024	0.016	0.000	0.890	-0.331
x16 cash / total debt	0.038	0.026	0.001	1.157	0.561
x17 cash-flow / equity	0.256	0.278	0.077	1.013	1.214
x18 cash-flow / sales	0.035	0.035	0.001	0.937	2.100
x19 cash-flow / total assets	0.032	0.027	0.001	0.625	0.189
x20 cash-flow / total debt	0.052	0.043	0.002	0.512	-0.478
x21 securitys beta	0.746	0.336	0.113	0.159	-0.705
x22 return on the security	0.129	0.105	0.011	0.180	1.514
x23 securitys total risk (variance)	0.091	0.048	0.002	1.137	1.316
x24 skewness of the return	0.218	0.705	0.497	0.271	0.522
x25 kurtosis of the return	0.183	1.274	1.624	1.447	3.351

The first subperiod 1974-78:

Variable	Mean	Std Dev	Variance	Skewness	Kurtosis
x1 CR current ratio	1.598	0.534	0.285	2.233	8.171
x2 QR quick ratio	0.817	0.380	0.145	0.860	1.922
x3 DI defensive interval measure	90.316	36.447	1328.350	0.835	0.732
x4 DE debt to equity	3.010	1.671	2.793	2.331	7.268
x5 LTDE long-term debt to equity	1.419	1.098	1.205	1.588	2.325
x6 TIE times interest earned	2.033	1.574	2.477	2.729	8.184
x7 ES earnings to sales	0.012	0.028	0.001	-0.656	1.579
x8 ROA return on assets	0.089	0.036	0.001	0.592	0.692
x9 ROE return on equity	0.045	0.117	0.014	-1.416	3.151
x10 TAT total assets turnover	1.296	0.807	0.651	1.858	3.151
x11 IT inventory turnover	5.223	7.252	52.591	4.785	24.951
x12 ART accounts receivable turnover	8.748	4.609	21.243	1.712	4.002
x13 cash / current debt	0.049	0.038	0.001	0.663	-1.038
x14 cash / sales	0.017	0.016	0.000	1.498	1.452
x15 cash / total assets	0.017	0.015	0.000	1.261	0.790
x16 cash / total debt	0.026	0.023	0.001	1.141	0.220
x17 cash-flow / equity	0.160	0.279	0.078	-0.160	3.167
x18 cash-flow / sales	0.025	0.043	0.002	1.261	5.433
x19 cash-flow / total assets	0.023	0.030	0.001	0.377	1.815
x20 cash-flow / total debt	0.036	0.044	0.002	-0.111	0.568
x21 securitys beta	0.729	0.445	0.198	-0.091	-0.874
x22 return on the security	-0.010	0.152	0.023	1.030	3.264
x23 securitys total risk (variance)	0.076	0.077	0.006	2.650	9.387
x24 skewness of the return	0.264	0.845	0.714	0.307	-0.091
x25 kurtosis of the return	-0.076	2.024	4.098	0.410	-0.403

The second subperiod 1979-84:

Variable	Mean	Std Dev	Variance	Skewness	Kurtosis
x1 CR current ratio	1.754	0.646	0.417	1.913	4.436
x2 QR quick ratio	1.029	0.445	0.198	1.308	2.373
x3 DI defensive interval measure	108.616	41.626	1732.687	0.787	0.820
x4 DE debt to equity	3.425	2.430	5.906	2.491	8.121
x5 LTDE long-term debt to equity	1.783	1.670	2.788	2.046	5.113
x6 TIE times interest earned	2.141	1.207	1.458	2.351	7.048
x7 ES earnings to sales	0.026	0.018	0.000	1.057	1.167
x8 ROA return on assets	0.113	0.026	0.001	0.594	-0.022
x9 ROE return on equity	0.116	0.061	0.004	0.314	-0.853
x10 TAT total assets turnover	1.293	0.690	0.476	1.786	2.670
x11 IT inventory turnover	5.919	8.528	72.733	5.176	28.145
x12 ART accounts receivable turnover	8.179	3.668	13.452	1.051	1.530
x13 cash / current debt	0.104	0.090	0.008	1.593	2.719
x14 cash / sales	0.034	0.023	0.001	0.399	-0.513
x15 cash / total assets	0.030	0.021	0.000	0.759	-0.487
x16 cash / total debt	0.048	0.038	0.001	1.670	3.492
x17 cash-flow / equity	0.335	0.331	0.110	1.187	1.092
x18 cash-flow / sales	0.044	0.034	0.001	0.571	-0.436
x19 cash-flow / total assets	0.039	0.031	0.001	0.516	-0.318
x20 cash-flow / total debt	0.065	0.056	0.003	0.829	0.067
x21 securitys beta	0.761	0.336	0.113	0.184	-0.422
x22 return on the security	0.244	0.112	0.013	0.317	-0.100
x23 securitys total risk (variance)	0.072	0.054	0.003	1.300	1.610
x24 skewness of the return	0.250	0.831	0.691	-0.757	0.974
x25 kurtosis of the return	0.065	1.875	3.516	0.678	-0.431