Association between Accounting and Market-Based Variables

A Canonical Correlation Approach with U.S. Data

Timo Salmi, Ilkka Virtanen, Paavo Yli-Olli and Juha-Pekka Kallunki

University of Vaasa
P.O.Box 700
FIN-65101 Vaasa
Finland

Paper presented in Workshop **Financial Statement Analysis**
University of Vaasa, August 7, 1997

Association between Accounting and Market-Based Variables
A Canonical Correlation Approach with U.S. Data

Abstract

- **The nature of the association between the firm's accounting and market-based variables is investigated using canonical correlation analysis.**

- **The data consists of NYSE and AMEX firms for 1976-93.**

- **A clear relationship between the firm's accounting and stock-market variables is observed.**

- **However, the accounting variables making up the relationship vary along time.**

- **The decomposed analysis of the association suggests that accrual-based financial ratios are crucial for security analysis. Cash-based financial ratios show increasing relevance over time.**

- **The effect of a reduction of the original set of the accounting variables into six key financial ratios is observed.**

- **The inclusion of the variance of the stock return into the market-based variable set is found to crucially increase the strength of the association.**

The general research problem

- The question of the existence, strength and stability of the association between the firm's accounting and market-based variables.

- The question of the relative usefulness of alternative accounting variables in explaining and predicting market behavior.

  Which of the two, accrual-based or cash-based accounting variables, contain more relevant information for security analysis.

- The question of a sufficient reduced set of accounting variables for successful security analysis.

- The discussion of whether the market beta is a sufficient measure of securities' riskiness.

Some earlier studies

- **The association between the firm's accounting beta and its security market beta.**

  Ball and Brown (1969)
  Beaver et al. (1970)
  Gonedes (1973)
  Bowman (1979)
  Ismail and Kim (1989)

- **Correlations between a single financial ratio, or cluster of financial ratios, and a security's return and risk.**

  Beaver et al. (1970)
  Pettit and Westerfield (1972)
  Martikainen (1991)
  Kim and Lipka (1991)

- **A general correlation between the two sets of variables, i.e. between the set of accounting variables and the set of market-based variables.**

  Salmi, Virtanen and Yli-Olli (1997)

Specific research questions

1) Is there a temporally stable general association (measured by canonical correlations) between the firm's accounting ratios and its stock return and risk?

2) Is the association with stock return and risk stronger for accrual-based or cash-based financial ratios? Does the potentially weaker set yet contain incremental information?

3) Does a reduced set of key financial ratios essentially retain the correlation between the firm's accounting ratios and its stock return and risk?

4) Is the general correlation between the firm's accounting ratios and its stock return and risk strengthened when the risk is measured by alternative risk measures?

Data description

- **The annual accounting data is retrieved from Compustat tapes for all the December firms listed on the NYSE and AMEX.**
- **The stock returns are obtained from CRSP tapes.**
- **The research period is from 1976 to 1993 and is divided into three subperiods 1976-1981, 1982-1987, and 1988-1993.**
- **The accounting variables**

  The twelve accrual-based financial ratios are the ones given in Foster (1978). The eight cash-based financial ratios follow Gombola and Ketz (1983). The values of the financial ratios are calculated separately for each subperiod by averaging the annual values of each individual ratio for each firm

- **The market-based variables**

  The five market-based variables are the security's beta, return on the security, total risk (variance), skewness of the return, and kurtosis of the return.
  The variance, kurtosis and skewness of the stock returns are calculated from the time series of 72 monthly returns for each of the three subperiods. The market betas are estimated by regressing the stock returns on the market return using the market model. The market return is obtained as the return on the SP500 index.

- **The sample contains 613 firms in 1976-81, 627 in 1982-87 and 612 in 1988-93.**

Results

♦ Empirical association between accounting and market-based variables (research question 1).

Table 1:

There is a clear general association between the firms' accounting and market-based variables.
The two canonical correlations between the variable sets are highly significant for all the three periods.
The numerical values of the first canonical correlation vary from 0.431 to 0.619, and from 0.293 to 0.499 for the second.

Table 2:

The structure of the existing association is not stable, the association is generated by different accounting variable combinations in the different periods.
The contribution of the financial leverage variables, however, is fairly stable (the coefficients of v_1 for the variables x_4 - x_6).

♦ Relative influence of accrual-based and cash-based variables in the association (research question 2).

Tables 3 and 4:

Both the accrual-based and cash-based accounting variables are significantly associated with the market-based variables.
The accrual-based set outperforms the cash-based set (in the period 1988-93 they are, however, at par).

Table 3 vs. Table 1:

Incremental information provided by the cash-based variables
- **Period 1976-81: relatively small**
- **Period 1982-87: negligible**
- **Period 1988-93: crucial**

♦ Association with the key financial ratios (research question 3).

Table 5:

Six key ratios in the predictor set

Liquidity (quick ratio x_2)
Dynamic liquidity (defensive interval measure x_3)
Solvency (debt to equity x_4)
Profitability (return on equity x_9)
Turnover (total asset turnover x_{10})
Cash-flows (cash-flow to sales x_{18})

Table 5 vs. Table 1:

The reduced set holds a crucial amount of information for security analysis, although a natural decrease in the information content appears

♦ Effect of additional risk measures on the association (research question 4).

Table 6 vs. Table 1:

The inclusion of the variance to the set of the market-based variables increases the association between the accounting variable set and the market-based variable set remarkably; also the emerging third canonical correlation is highly significant for all the three periods.

Table 7 vs. Table 6:

The inclusion of skewness and kurtosis does not enhance the association between the accounting and market-based variable sets.

Conclusion

- **There exists a general association between the firm's accounting ratios and its stock return and risk, but the association is structurally unstable: the accounting variables making up the relationship vary along time.**

- **When taken alone, both the accrual-based and the cash-based variables are significantly associated with the market-based variables. The accrual-based variable set has a stronger relationship with the market-based variable set than the cash-based set. With the exception of the period 1988-93 the incremental information of the cash-based set is not notable.**

- **The reduction of the original set of the accounting variables (20 financial ratios) into six key ratios retains a significant association. The resulting drop in strength of the association is about one third.**

- **The inclusion of the variance of the stock return into the market-based variable set as a measure of the total risk crucially increases the strength of the association. The inclusion of the higher moments (skewness and kurtosis) have no influence on the association.**

Table 1. Canonical correlations and their statistical significance: return and beta vs. all financial ratios

	Canonical variable	Canonical correlation	Approxim. F	p-value
Panel A	1	0.438	5.430	0.0001
1976-81	2	0.341	4.113	0.0001
Panel B	1	0.619	14.207	0.0001
1982-87	2	0.499	10.588	0.0001
Panel C	1	0.431	4.693	0.0001
1988-93	2	0.293	2.923	0.0001

Table 2. Standardized canonical coefficients

Panel A: Coefficients for the predictor (the accounting) variables

	1976-81		1982-87		1988-93		
	v_1	v_2	v_1	v_2	v_1	v_2	
x_1	-0.063	0.295	-0.128	0.547	0.191	-0.678	current ratio
x_2	0.111	0.430	-0.053	-0.597	-0.114	0.530	quick ratio
x_3	0.901	-0.578	-0.350	0.529	0.381	0.171	defensive interval measure
x_4	0.057	0.096	0.062	-0.320	0.162	-0.759	debt to equity
x_5	0.220	0.312	0.179	0.189	0.492	0.795	long-term debt to equity
x_6	0.428	-0.136	0.070	-0.121	0.013	0.185	times interest earned
x_7	-0.361	-0.177	0.588	-0.557	0.434	-0.548	earnings to sales
x_8	0.798	0.283	0.408	0.912	-0.336	1.315	return on assets
x_9	-0.258	0.736	0.064	-0.327	0.054	-0.527	return on equity
x_{10}	0.009	0.493	-0.018	0.311	-0.186	0.562	total assets turnover
x_{11}	0.154	0.294	-0.057	0.136	-0.063	-0.142	inventory turnover
x_{12}	-0.147	0.112	0.004	-0.122	-0.251	0.005	accounts receivable turnover
x_{13}	0.336	-1.208	-0.115	0.072	0.281	0.520	cash / current debt
x_{14}	-0.455	0.677	0.049	-0.396	-0.778	-0.826	cash / sales
x_{15}	0.507	0.329	0.103	0.412	0.658	-0.298	cash / total assets
x_{16}	-0.671	0.363	0.230	-0.194	-0.239	0.929	cash / total debt
x_{17}	0.216	-0.572	0.074	-0.048	-0.159	0.054	cash flow / equity
x_{18}	-0.495	1.205	-0.140	-0.383	-1.039	0.468	cash flow / sales
x_{19}	-0.195	-0.137	0.259	0.472	1.327	-0.712	cash flow / total assets
x_{20}	-0.477	-0.075	-0.362	-0.304	-0.467	-0.502	cash flow / total debt

Panel B: Coefficients for the criterion (the market-based) variables

	1976-81		1982-87		1988-93		
	w_1	w_2	w_1	w_2	w_1	w_2	
x_{21}	0.594	0.969	0.820	0.581	0.241	0.970	security's beta
x_{22}	0.569	-0.984	-0.492	0.876	0.972	-0.232	return

Table 3. Canonical correlations and their statistical significance: return and beta vs. accrual-based financial ratios

	Canonical variable	Canonical correlation	Approxim. F	p-value
Panel A	1	0.363	5.441	0.0001
1976-81	2	0.252	3.689	0.0001
Panel B	1	0.604	21.609	0.0001
1982-87	2	0.471	15.950	0.0001
Panel C	1	0.313	3.275	0.0001
1988-93	2	0.154	1.322	0.2075

Table 4. Canonical correlations and their statistical significance: return and beta vs. cash-based financial ratios

	Canonical variable	Canonical correlation	Approxim. F	p-value
Panel A	1	0.212	2.734	0.0003
1976-81	2	0.158	2.216	0.0314
Panel B	1	0.409	13.054	0.0001
1982-87	2	0.349	12.239	0.0001
Panel C	1	0.347	6.234	0.0001
1988-93	2	0.175	2.734	0.0084

Table 5. Canonical correlations and their statistical significance: return and beta vs. reduced set of financial ratios.

	Canonical variable	Canonical correlation	Approxim. F	p-value
Panel A	1	0.324	8.263	0.0001
1976-81	2	0.214	5.821	0.0001
Panel B	1	0.445	17.758	0.0001
1982-87	2	0.304	12.637	0.0001
Panel C	1	0.285	4.771	0.0001
1988-93	2	0.088	0.937	0.4561

Table 6. Canonical correlations and their statistical significance: return, beta and variance vs. all financial ratios

	Canonical variable	Canonical correlation	Approxim. F	p-value
Panel A	1	0.618	8.630	0.0001
1976-81	2	0.422	4.806	0.0001
	3	0.295	3.147	0.0001
Panel B	1	0.782	17.727	0.0001
1982-87	2	0.450	7.759	0.0001
	3	0.372	5.398	0.0001
Panel C	1	0.600	8.113	0.0001
1988-93	2	0.423	4.707	0.0001
	3	0.286	2.928	0.0001

Table 7. Canonical correlations and their statistical significance: return, beta, variance, skewness and kurtosis vs. all financial ratios.

	Canonical variable	Canonical correlation	Approxim. F	p-value
Panel A	1	0.620	5.608	0.0001
1976-81	2	0.435	3.138	0.0001
	3	0.296	1.978	0.0001
	4	0.216	1.490	0.0357
	5	0.188	1.357	0.1575
Panel B	1	0.783	10.189	0.0001
1982-87	2	0.501	4.261	0.0001
	3	0.375	2.485	0.0001
	4	0.213	1.126	0.2845
	5	0.126	0.609	0.8781
Panel C	1	0.613	5.473	0.0001
1988-93	2	0.431	3.100	0.0001
	3	0.309	1.975	0.0001
	4	0.196	1.335	0.0961
	5	0.189	1.362	0.1549

APPENDIX A.

A Brief Review of the Canonical Correlation Analysis

Canonical correlation analysis is a more general case of the usual multiple regression analysis. In 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 $x_1, x_2, ..., x_p$ and another battery of variables, the criterion variables $y_1, y_2, ..., y_q$.

The pairwise correlations within and between the x_i and the y_j variable sets can be presented as matrix

(1) $$\mathbf{R} = \begin{pmatrix} \mathbf{R_{yy}} & \mathbf{R_{yx}} \\ \mathbf{R_{xy}} & \mathbf{R_{xx}} \end{pmatrix}$$

The x and y variables can be assumed to have been routinely standardized to a zero mean and a unit standard deviation.

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

(2) $$\mathbf{v} = \sum_{i=1}^{p} \mathbf{a_i x_i}$$

(3) $$\mathbf{w} = \sum_{j=1}^{q} \mathbf{b_j y_j}$$

where the canonical coefficients a_i and b_j are adjusted to make the v and w variables standardized as well. To solve the canonical correlation the ordinary bivariate correlation between the composites v and w

(4) $$\mathbf{R_C} = \frac{\mathbf{1}}{\mathbf{m-1}} \sum_{k=1}^{m} \mathbf{v_k w_k}$$

is maximized. In Formula (4) m is the number of observations, and v_k and w_k are the observed values for the v and w variables.

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.

APPENDIX B: Definitions of the variables using Compustat codes.

Symbol	Variable	Compustat Definition
x_1	current ratio	(4)/(5)
x_2	quick ratio	[(1)+(2)]/(5)
x_3	defensive interval measure	[(4)-(3)]/
x_4	debt to equity	(181)/(216)
x_5	long-term debt to equity	(9)/(216)
x_6	times interest earned	(13)/(15)
x_7	earnings to sales	(172)/(12)
x_8	return on assets	[(18)+(15)]/[(6)]
x_9	return on equity	(18)/[(216)+(50)]
x_{10}	total assets turnover	(12)/(6)
x_{11}	inventory turnover	(12)/(3)
x_{12}	accounts receivable turnover	(12)/(2)
x_{13}	cash / current debt	(1)/(5)
x_{14}	cash / sales	(1)/(12)
x_{15}	cash / total assets	(1)/(6)
x_{16}	cash / total debt	(1)/(181)
x_{17}	cash flow / equity	[(13)-{d[(4)-(1)]-d(5)}] / (216)
x_{18}	cash flow / sales	[(13)-{d[(4)-(1)]-d(5)}] / (12)
x_{19}	cash flow / total assets	[(13)-{d[(4)-(1)]-d(5)}] / (6)
x_{20}	cash flow / total debt	[(13)-{d[(4)-(1)]-d(5)}] / (181)
x_{21}	security's beta	
x_{22}	return on the security	
x_{23}	security's total risk (variance)	
x_{24}	skewness of the return	
x_{25}	kurtosis of the return	

APPENDIX C: The Basic Statistics of the Variables

	1976-81		1982-87		1988-93	
	mean	std	mean	std	mean	std
x_1	2.202	0.891	1.949	0.971	1.854	1.175
x_2	1.177	0.472	1.125	0.633	1.112	0.909
x_3	0.277	0.223	0.294	0.175	0.312	0.240
x_4	1.396	1.930	1.562	2.017	1.786	1.371
x_5	0.562	0.637	0.653	0.903	0.760	0.750
x_6	15.341	28.039	11.627	31.077	11.783	30.325
x_7	0.053	0.059	0.046	0.069	0.041	0.094
x_8	0.086	0.031	0.070	0.040	0.065	0.047
x_9	0.113	0.149	0.059	0.273	0.071	0.183
x_{10}	1.416	0.740	1.136	0.658	1.088	0.715
x_{11}	11.633	16.018	15.152	24.930	18.925	32.848
x_{12}	10.823	27.378	9.342	17.012	11.503	41.187
x_{13}	0.333	0.288	0.372	0.463	0.380	0.728
x_{14}	0.064	0.080	0.083	0.127	0.086	0.165
x_{15}	0.072	0.057	0.071	0.074	0.066	0.080
x_{16}	0.166	0.169	0.171	0.275	0.163	0.322
x_{17}	0.329	0.290	0.317	0.210	0.346	0.238
x_{18}	0.135	0.102	0.165	0.124	0.165	0.125
x_{19}	0.150	0.060	0.137	0.060	0.130	0.064
x_{20}	0.333	0.203	0.287	0.188	0.256	0.196
mean	0.020	0.012	0.015	0.009	0.015	0.015
beta	1.252	0.451	0.983	0.388	0.847	0.464
vari	0.011	0.007	0.010	0.007	0.010	0.018
skew	0.182	0.511	-0.257	0.638	0.082	0.626
kurt	1.166	1.814	1.954	2.470	1.184	2.189