

**TIMS XXVI
COPENHAGEN
Denmark**

June 17-21, 1984



**THE INSTITUTE OF MANAGEMENT SCIENCES
XXVI INTERNATIONAL MEETING**

TIMS XXVI
COPENHAGEN
Denmark
June 17 - 21, 1984

ON INFORMATION BASED DECOMPOSITION MEASURES
IN FINANCIAL STATEMENT ANALYSIS

by

Erkki Latosaari and
DAVA, Inc.
Tieteenkatu 1
33720 Tampere
Finland

Ilkka Virtanen
School of Business Studies
University of Vaasa
Vaasa
Finland

ON INFORMATION BASED DECOMPOSITION MEASURES
IN FINANCIAL STATEMENT ANALYSIS

by

ERKKI LATOSAARI and ILKKA VIRTANEN
School of Business Studies
University of Vaasa
Finland

ON INFORMATION BASED DECOMPOSITION MEASURES IN FINANCIAL STATEMENT ANALYSIS

1 Introduction

This paper deals with the use and interpretation of decomposition measures based on the concept of entropy in financial statement analysis. The application is connected with the interpretation of entropy as a measure of dispersion. The correlations between decomposition measures and sixteen financial ratios are analyzed. Decomposition measures spanning over several years are also studied in sections 4 and 5. The data utilized is for the period 1970 - 1980 and includes fifteen Finnish firms.

Entropy can be interpreted as a measure of dispersion which due to the general nature of definition, can be used in the analysis of various variables. Entropy has been used in economics when studying, for example, the structure of markets, centralization of industry and when testing different statistical hypotheses. In these applications, entropy is considered primarily as a measure of dispersion.

The use of entropy originated in physics where changes in the states of thermodynamic systems are described with the help of entropy. A general law describing the direction of thermal energy flows (the second law of thermodynamics) can be defined with entropy.

Entropy also is an important concept in information theory where it can be used as a tool for matching information streams with channel capacities. The mathematical expression of entropy is also based on information theory. However, information theory is primarily a theory connected with statistical probabilities of different combinations of signals and as such it is not associated with economics.

The thermodynamic and information theoretic interpretations of entropy have unfortunately been often the reason for misunderstanding of the relevance of entropy in economics.

2 Definitions and properties of entropy

In statistics entropy is a measure of dispersion for qualitative data. For a qualitative variable X , the value of the variable may be quite arbitrary. The whole information is in the class frequencies or probabilities. In order to get a dispersion index for the distribution, only these probabilities can be used (Astola and Virtanen 1981).

Consider the frequency distribution of a qualitative variable X .

Table 1.

classes	relative frequencies
E 1	p 1
E 2	p 2
.	.
.	.
E N	p N

$$\sum_{i=1}^N p_i = 1$$

The entropy of variable X is now defined as

$$(2.1) \quad H = -k \sum_{i=1}^N p_i \log p_i$$

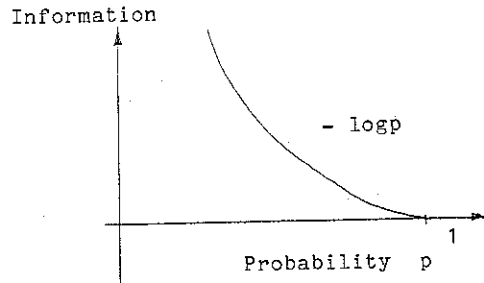
The coefficient k can be chosen according to the base of the logarithm to be used. In general logarithms with base 2, widely employed in information theory, are used. The unit of entropy is then called a "bit". When natural logarithms are used, the unit is called a "nit".

On the basis of the definition the following properties can be noted.

1. H is non-negative.
2. $H = 0$ only if one $p_i = 1$ (and all other $p_i = 0$).
3. H depends only on frequencies (probabilities).
4. H reaches maximum value $\log N$ when $p_1 = p_2 = \dots = p_N = 1/N$.
5. H can be decomposed within and between entropies.

Definition (2.1) derives from the mathematical information theory the following sense. It is assumed that the information received from a specific event can be expressed as a monotonically decreasing function of the probability of the event. The negative logarithm function fulfils this requirement.

Figure 1



Consequently, if the event is "certain" the information received equals zero, while the information of a rare event would be high. The expected information can thus be defined according to equation (2.1).

Also other measures can be derived from information theory (Kullback 1966, 5-10). Consider there is a prior information $-log q_i$ from an event to be examined. If, however,

posterior probability p_i is observed, the information received from the transformation prior probability q_i to p_i can be expressed by the difference

$$(2.2) \quad \log(1/q_i) - \log(1/p_i) = \log(p_i/q_i)$$

The expected value of this information is then

$$(2.3) \quad I(p;q) = \sum_{i=1}^N p_i \log(p_i/q_i)$$

This is often called information inaccuracy. The definition shows that $I(p;q)$ reaches the minimum value 0 when all p_i and q_i are equal for all i . $I(p;q)$ can thus be interpreted as a measure of "information inaccuracy".

It can be shown that (2.3) is approximately distributed as the χ^2 -distribution (Kullback 1966, 101-102). Tests can be applied when studying how much the observed distribution differs from the expected one (Hauser 1977). The null hypothesis can be, for example, the homogeneity of groups (Latosari and Virtanen 1983).

3. Financial statement analysis

The statistical interpretation of entropy makes it possible to analyze structural changes in financial statements. Measures based on definitions of entropy have been suggested for use in structural analyses of financial statements (Theil 1969, Lev 1974, 47-60, Walker etc. 1979) and in prediction of bankruptcy as well as corporation takeovers (Belkaoui 1976). Lev states that with decomposition analysis it is possible to identify whether significant change in financial constructs have occurred and, moreover, where most of the change is located. Any structural changes whether planned or unplanned, are of interest to the financial analyst. Changes may indicate changes in management strategy or management's inability to maintain a desired structure (Walker etc. 1979, 173-174).

The definition (2.3) with its properties suits well the approach concerned. The measure receives high values when changes are observed in successive relative proportions.

The decomposition measure can be calculated for the income statement (on certain conditions) and for the balance sheet as a whole or any combination of account balances. In general, the measure has been employed for the whole balance sheet (BSDM), for assets (ADM) and liabilities (LDM).

The categories of the balance sheet are divided in both assets and liabilities into three classes. If p_{ij} is the relative proportion of the sum of assets when $j = 1$ and liabilities when $j = 2$, then the six classes sum to unity.

$$(3.1) \quad \sum_{i=1}^3 \sum_{j=1}^2 p_{ij} = 1 \quad (3.2) \quad \sum_{i=1}^3 p_{i1} = 0.5$$

$$(3.3) \quad \sum_{i=1}^3 p_{i2} = 0.5$$

(3.2) is the sum of assets and (3.3) the sum of liabilities

Balance sheet proportions

	assets	liabilities	
Quick assets	p_{11}	p_{12}	Short-term debt
Inventory	p_{21}	p_{22}	Long-term debt
Long-term assets	p_{31}	p_{32}	Net Worth
Total	0.5	0.5	Total

The measures are defined with two balance sheets for different points in time by using Kullback's definition (2.3). If fractions from earlier balance sheet are expressed as p_{ij} and fractions from later balance sheet as q_{ij} then

$$(3.4) \quad \text{BSDM} = \sum_{i=1}^3 \sum_{j=1}^2 p_{ij} \log(p_{ij}/q_{ij})$$

$$(3.5) \quad \text{ADM} = \sum_{i=1}^3 2p_{i1} \log(2p_{i1}/2q_{i1})$$

$$(3.5) \quad \text{ADM} = \sum_{i=1}^3 2p_{i2} \log(2p_{i2}/2q_{i2})$$

These definitions are based on the decomposition property of entropy. BSDM represents "between" groups and ADM and LDM "within" groups entropies. It can be stated that BSDM is the average of ADM and LDM. The greater the difference between the relative proportions of the earlier and later balance sheets the higher the numerical values of the measures are. The measures indicate only the amount of change, not the direction. It has been found that the decomposition measures are generally larger for small firms than for large firms. Further, it has been found that the LDM is generally larger than the ADM.

Decomposition measures have been suggested for use in the prediction of company bankruptcy. Empirical results indicate that decomposition measures are generally larger for failed than for non-failed firms. It has also been found that decomposition measures have approximately the same predictive power as most of the traditional ratios. The discriminating ability between solvent and bankrupt firms is, however, not fully convincing.

It has also been found that decomposition measures are closely related to changes in company cash flows. The results also show that correlation only occurs between the absolute values of changes and decomposition measures (Ball etc. 1976). Consequently, the measures observed do not indicate whether the changes have been favourable or unfavourable to the firm.

There are thus good grounds for questioning the validity of decomposition measures when evaluating the firm's financial condition. If high measures were interpreted to predict bankruptcy, all structural changes in the balance sheet would be negative phenomena for the firm. Still structural changes are also associated with positive developments as well, so the prediction of bankruptcy by using decomposition measures cannot, at least in theoretical terms, be considered appropriate.

The decomposition measures could be used instead for monitoring financial statements for a longer period of time at a general level. If considerable numerical values of measures are observed, the financial statements can be examined closer, and the financial development during the period concerned evaluated with more sophisticated measures. To be able to use decomposition measures in an appropriate way in the general evaluation it should be assumed that there is a clear correlation between decomposition measures and financial ratios. This would mean that when observing considerable values of measures, changes in the ratios describing firm's financial condition could also be expected. This type of correlation has been studied between decomposition measures and the absolute changes in values of usual ratios (Walker etc. 1979). In this research it was found that the BSDM and the LDM are highly correlated to the absolute changes in values of ratios. With regard to the ADM the correlation was smaller.

Discriminant analysis is also widely used for analyzing financial statements. The scores used are not separate measures but linear combinations of measures, such as combination score Z. Also in this case the decomposition measures apparently correlate with the score used, because they correlate with the components of the score. If a reliable discriminant model is in use for the firm monitored, the use of decomposition measures does not give any further information because the changes can be observed by using the combination too.

It should be noted, however, that when using combinations the combinations are estimated from specific data. The question is whether the firm monitored is in agreement with the data employed in estimation. Also the stability of linear combinations may be questionable (Aho 1981, 72-114). In these cases, decomposition measures can be calculated to support the evaluation, because they are not dependent on any statistical estimation (Walker etc. 1979).

It should also be observed that any comparing analysis of balance sheets cannot be based on the relative proportions of balance sheet items alone. The decomposition of balance sheet may in some cases vary across the firms examined. However, the properties of decomposition measures make it possible to compare the structural changes in differently constructed balance sheets as well.

As was earlier mentioned, decomposition measures could, in principle be defined also for other financial statements for instance for income statement. The practical limitation is the possibility of negative proportions which cannot be handled by the basic definitions. Apparently, the use of decomposition measures in these cases would become too complex.

4. Correlation between financial ratios and decomposition measures

In this section the correlation between decomposition measures and seventeen financial ratios is studied. Fifteen Finnish firms are examined in the period of 1970 - 1981. In order to observe gradual structural changes in the same direction, the measures spanning over several years are also studied.

The Spearman rank correlation coefficients are calculated between decomposition measures and changes in absolute values of ratios for each firm in the 11 year period. The values presented in the tables are averages of these correlations.

4.1 Decomposition measures spanning one year

Decomposition measures are calculated by the basic definitions (3.4), (3.5) and (3.6). The relative shares p and q are successive relative proportions.

It was observed that LDM is generally larger than ADM as previously reported. Compared between the firms the decomposition measures did not vary very much. In this study the firm sizes were however quite homogeneous and therefore general conclusions about the variability of decomposition measures across the firm size can not be drawn on the basis of this data.

Averages of the correlations are presented in the table 2. The ratios used are

- CR Current ratio
- DE Debt to equity ratio
- Kpot Return on total assets
- Lvt Earnings before int&taxes/sales
- Mskn Trades receivable turnover
- Mt Net income/sales
- Omax Equity to total assets
- Opot Return on equity
- Ovkn Trades payable turnover
- Pokn Total assets turnover
- Porl Total debt to total assets
- ROI Return on investment
- QR Quick ratio
- Rt Cash flow/total assets
- Vkn Inventories turnover
- Vpkn Debt turnover

The D in front of the names in following Tables is for difference in absolute value.

CORRELATION	SAS 17:59 MONDAY, APRIL 23, 1984 37			SAS 17:59 MONDAY, APRIL 23, 1984 38		
	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MEAN	STANDARD DEVIATION	MINIMUM VALUE
RSDM	0.55125369	0.27227669	-0.05454545	0.14030848	0.40097366	-0.60000000
ADM	0.22003559	0.31707512	-0.52380952	0.13521688	0.27072687	-0.29090909
LDM	0.56230657	0.30928995	-0.13036364	0.07576044	0.40933484	-0.61212121
RSDM	0.41784680	0.31384657	-0.28181818	0.37288969	0.22197165	-0.04545455
ADM	0.21753384	0.24191312	-0.30000000	0.15443371	0.3499010	-0.44242424
LDM	0.45226458	0.30734870	-0.31818182	0.37105275	0.21897008	-0.01818182
RSDM	0.22417362	0.25754676	-0.82857143	0.43007844	0.28105645	-0.11818182
ADM	0.20541842	0.25858482	-0.37142857	0.09767273	0.27713268	-0.40909091
LDM	0.09522089	0.30558859	-0.77142857	0.42029455	0.29830193	-0.32121212
RSDM	0.22788584	0.28072129	-0.45714286	0.15788486	0.31145229	-0.94285714
ADM	0.22688583	0.23558472	-0.60474190	0.10818182	0.40038627	-0.71428571
LDM	0.12884665	0.22758453	-0.20000000	0.18105330	0.30563566	-0.60000000
RSDM	-0.00832157	0.31697891	-0.52727273	0.19051059	0.26752952	-0.27272727
ADM	-0.10960730	0.37882875	-0.74545455	0.13731258	0.26997075	-0.48571429
LDM	0.04967828	0.32400033	-0.56363636	0.14415584	0.32568296	-0.31818182
RSDM	0.17234598	0.28948067	-0.37142857	0.31875806	0.27350722	-0.21428571
ADM	0.08995442	0.30657059	-0.41818182	0.21488489	0.33744815	-0.55714286
LDM	0.19084029	0.21106179	-0.24848485	0.20613229	0.27861021	-0.28181818
RSDM	0.4750492	0.23955645	-0.22727273	0.25470708	0.26333825	-0.30909091
ADM	0.23641854	0.24170032	-0.30909091	0.21863958	0.24051744	-0.50000000
LDM	0.48113187	0.28023600	-0.33636364	0.19948169	0.29328506	-0.36363636
RSDM	0.21856598	0.28522388	-0.65714286	0.31875806	0.27350722	-0.21428571
ADM	0.12743041	0.23341429	-0.21428571	0.21488489	0.33744815	-0.55714286
LDM	0.19561366	0.30287668	-0.65714286	0.20613229	0.27861021	-0.28181818
RSDM	0.20916941	0.28000360	-0.47878788	0.25470708	0.26333825	-0.30909091
ADM	0.02324259	0.31102679	-0.46666667	0.21863958	0.24051744	-0.50000000
LDM	0.20801947	0.29586921	-0.45454545	0.19948169	0.29328506	-0.36363636

Table 2 Averages of correlations time spanning one year

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
--- ROW VARIABLE NAME=DGR ---				
BSDM	0.42743089	0.34983113	-0.23333333	0.73333333
ADM	0.35915524	0.37211000	-0.27272727	0.45000000
LDM	0.44252970	0.32802272	-0.13333333	0.91214188
--- ROW VARIABLE NAME=BOE ---				
BSDM	0.33043302	0.32056625	-0.16787879	0.81167945
ADM	0.17822951	0.27483885	-0.38333333	0.48484848
LDM	0.38954870	0.37404898	-0.23646364	0.73333333
--- ROW VARIABLE NAME=DKPOT ---				
BSDM	0.17451515	0.39063454	-0.51666667	0.70709091
ADM	0.29147840	0.44119432	-0.73333333	0.81818182
LDM	0.18939381	0.39324953	-0.58666667	0.72121212
--- ROW VARIABLE NAME=DLVT ---				
BSDM	0.22343761	0.43423934	-0.55000000	0.90000000
ADM	0.25316877	0.43548239	-0.68333333	0.90000000
LDM	0.21077795	0.44553846	-0.61666667	0.86666667
--- ROW VARIABLE NAME=DHSMN ---				
BSDM	-0.03201089	0.445221071	-0.78181818	0.78333333
ADM	-0.10416942	0.43524187	-0.71428571	0.65000000
LDM	0.05802773	0.43952710	-0.64848485	0.75000000
--- ROW VARIABLE NAME=DHT ---				
BSDM	0.24811720	0.44982034	-0.66666667	0.83030303
ADM	0.29238419	0.44528441	-0.50000000	0.98666667
LDM	0.22087073	0.44346607	-0.75000000	0.79393939
--- ROW VARIABLE NAME=DOHNV ---				
BSDM	0.32281528	0.36514379	-0.35909242	0.79393939
ADM	0.22448548	0.33122715	-0.35909242	0.74545455
LDM	0.33792755	0.39045368	-0.34545455	0.98561076
--- ROW VARIABLE NAME=DOPOI ---				
BSDM	0.26962917	0.42774883	-0.61666667	0.90303030
ADM	0.29976836	0.46648542	-0.58333333	0.78333333
LDM	0.29836678	0.44945360	-0.70000000	0.91515152
--- ROW VARIABLE NAME=DOVNR ---				
BSDM	0.00662401	0.30561706	-0.47878788	0.60000000
ADM	0.03470843	0.37291532	-0.57575758	0.64646467
LDM	0.01463565	0.10368095	-0.54285714	0.89000000

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
--- ROW VARIABLE NAME=DGR ---				
BSDM	0.33501866	0.44767431	-0.80000000	0.73333333
ADM	0.29380538	0.51503843	-1.00000000	0.82000000
LDM	0.25191342	0.34582791	-0.43333333	0.86666667
--- ROW VARIABLE NAME=BOE ---				
BSDM	0.35096419	0.34834122	-0.23333333	0.90000000
ADM	0.23743015	0.43378227	-0.54761905	0.91666667
LDM	0.38823298	0.32949366	-0.23333333	1.00000000
--- ROW VARIABLE NAME=DKPOT ---				
BSDM	0.40168225	0.39807436	-0.80000000	0.95238095
ADM	0.26088773	0.39332430	-0.57142857	0.88095238
LDM	0.32989433	0.37792872	-0.60000000	0.96476190
--- ROW VARIABLE NAME=DLVT ---				
BSDM	0.20710350	0.40569225	-0.80000000	0.80952381
ADM	0.13740331	0.40238165	-1.00000000	0.59476190
LDM	0.27741047	0.45732296	-0.42857143	0.92857143
--- ROW VARIABLE NAME=DHSMN ---				
BSDM	0.00957059	0.36648580	-0.61904762	0.58333333
ADM	-0.04819544	0.43164614	-0.75000000	0.52444447
LDM	-0.11089175	0.34831870	-0.80000000	0.40000000
--- ROW VARIABLE NAME=DHT ---				
BSDM	0.23898072	0.35538764	-0.80000000	0.75000000
ADM	0.20602125	0.37100888	-0.54761905	0.73809524
LDM	0.28461236	0.29083621	-0.60000000	0.60000000
--- ROW VARIABLE NAME=DOHNV ---				
BSDM	0.34275244	0.42102854	-0.38333333	0.91666667
ADM	0.26108080	0.48420234	-0.56289434	0.79333333
LDM	0.32948293	0.40216710	-0.53333333	1.00000000
--- ROW VARIABLE NAME=DOPOI ---				
BSDM	0.21320346	0.41418921	-0.80000000	0.86666667
ADM	0.21674806	0.41113045	-0.69847619	0.85000000
LDM	0.23983865	0.37595378	-0.60000000	0.78333333
--- ROW VARIABLE NAME=DOVNR ---				
BSDM	0.00952567	0.41571278	-0.80952381	0.66666667
ADM	-0.06400469	0.43555770	-0.83333333	0.73809524
LDM	-0.07400798	0.40294460	-0.85714286	0.59523810

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
--- ROW VARIABLE NAME=DFOPN ---				
BSDM	0.15113107	0.27618689	-0.46666667	0.45454545
ADM	0.09401004	0.32805503	-0.57477915	0.51666667
LDM	0.09888120	0.24929828	-0.41666667	0.53939394
--- ROW VARIABLE NAME=DFODI ---				
BSDM	0.48644836	0.29754505	-0.09090909	0.90000000
ADM	0.27170700	0.37483490	-0.31428571	0.90000000
LDM	0.58239102	0.38894474	-0.08666667	0.94285714
--- ROW VARIABLE NAME=DGR ---				
BSDM	0.31237904	0.33307452	-0.40000000	0.81666667
ADM	0.15748981	0.23063379	-0.40000000	0.46666667
LDM	0.31903011	0.30078541	-0.16363636	0.73333333
--- ROW VARIABLE NAME=DKPOT ---				
BSDM	0.24537656	0.37803464	-0.53333333	0.72121212
ADM	0.21377188	0.36166589	-0.50000000	0.76666667
LDM	0.21810881	0.35050994	-0.63333333	0.71428571
--- ROW VARIABLE NAME=DHT ---				
BSDM	0.20329768	0.41997974	-0.53333333	0.71666667
ADM	0.23757162	0.43364009	-0.71666667	0.70909091
LDM	0.14802171	0.45774967	-0.73333333	0.79393939
--- ROW VARIABLE NAME=DOHNV ---				
BSDM	0.18952922	0.37487711	-0.60000000	0.80000000
ADM	0.10386268	0.36784781	-0.60000000	0.70909091
LDM	0.14181825	0.36980421	-0.46666667	0.78333333
--- ROW VARIABLE NAME=DOVNR ---				
BSDM	0.27434636	0.46891366	-0.70000000	0.85000000
ADM	0.14526189	0.46253282	-0.70000000	0.83333333
LDM	0.29919777	0.40481396	-0.43333333	0.80000000

Table 3 Averages of correlations time spanning two years

Table 4 Averages of correlations time spanning three years

As expected, the correlations are higher for financial ratios calculated directly from the fractions of balance sheet. The correlations for ratios based partly on income flows seem to be lower instead.

It can also be seen from the minimum and maximum values of in the table that the correlations vary considerably across the firms. However for most ratios and firms the correlations differ significantly from zero. It should also be stated that the interpretation of the numerical value of the Spearman rank correlation coefficient is not easy. Spearman rank correlation was chosen in this study primarily because of the skewed distributions of the financial ratios in the data.

4.2 Decomposition measures spanning over several years

In this case the decomposition measures were computed by using intervals of two and three years. Changes in the values of ratios were defined respectively and the Spearman rank correlations were computed. The results in Tables 3 and 4 do not differ significantly from those results where the basic definition was used.

5 Decomposition measures as indicators of abnormal periods

In this section illustrative examples concerning the use of decomposition measures in monitoring financial statements are presented.

In the figure 2, decomposition measures for one particular company are presented graphically as functions of time. The time spanning is one year.

This graphical representation shows that during the period of 78 - 79 changes have occurred mostly in the liabilities side of the balance sheet. In Figure 3 respective relative proportions of balance sheet are presented graphically. It is easy to see the large change in short-term debt during the period.

Considerable changes in the asset side during the periods of 1970 - 1971 and 1973 - 1974 are also presented in Figure 2 by peaks in ADM (asset decomposition measure). In these periods also the ratios used in this study varied considerably. Percentage changes varied from 10 per cent to 300 per cent.

In Figure 4 a different spanning was used for another company. The measures were now detecting gradual changes in the same direction during three years periods. Interesting periods seem to be 73 - 76 in the liabilities side and 74 - 77 in the asset side. Inspection of Figure 5 confirms the observation.

6 Conclusions

It is important to notice again that the method presented in this paper gives no information about the quality of the change detected. Once high values of decomposition measures are observed more advanced measures are needed in order to evaluate the financial position of the firm.

However, decomposition measures seem to be well suited for monitoring a large amount of financial statements at general level. One possible application is to use these measures as keys in computer aided search in large databases. Decomposition measures are not bounded to any specific structure of balance sheet (as e.g. in the one used in this study) and therefore they can be used as general measures of variability.

The problem is to decide an appropriate threshold value for the measures. In the previous examples an arbitrary value of 0.10 was used to classify the value as "significant". These judgements should obviously rely on previous experience.

Figure 2

DECOMPOSITION MEASURES

YRITYS=KEMI

Time spanning one year

PLOT OF BSDM*VV SYMBOL USED IS *
 PLOT OF LDM*VV SYMBOL USED IS #
 PLOT OF ADM*VV SYMBOL USED IS +

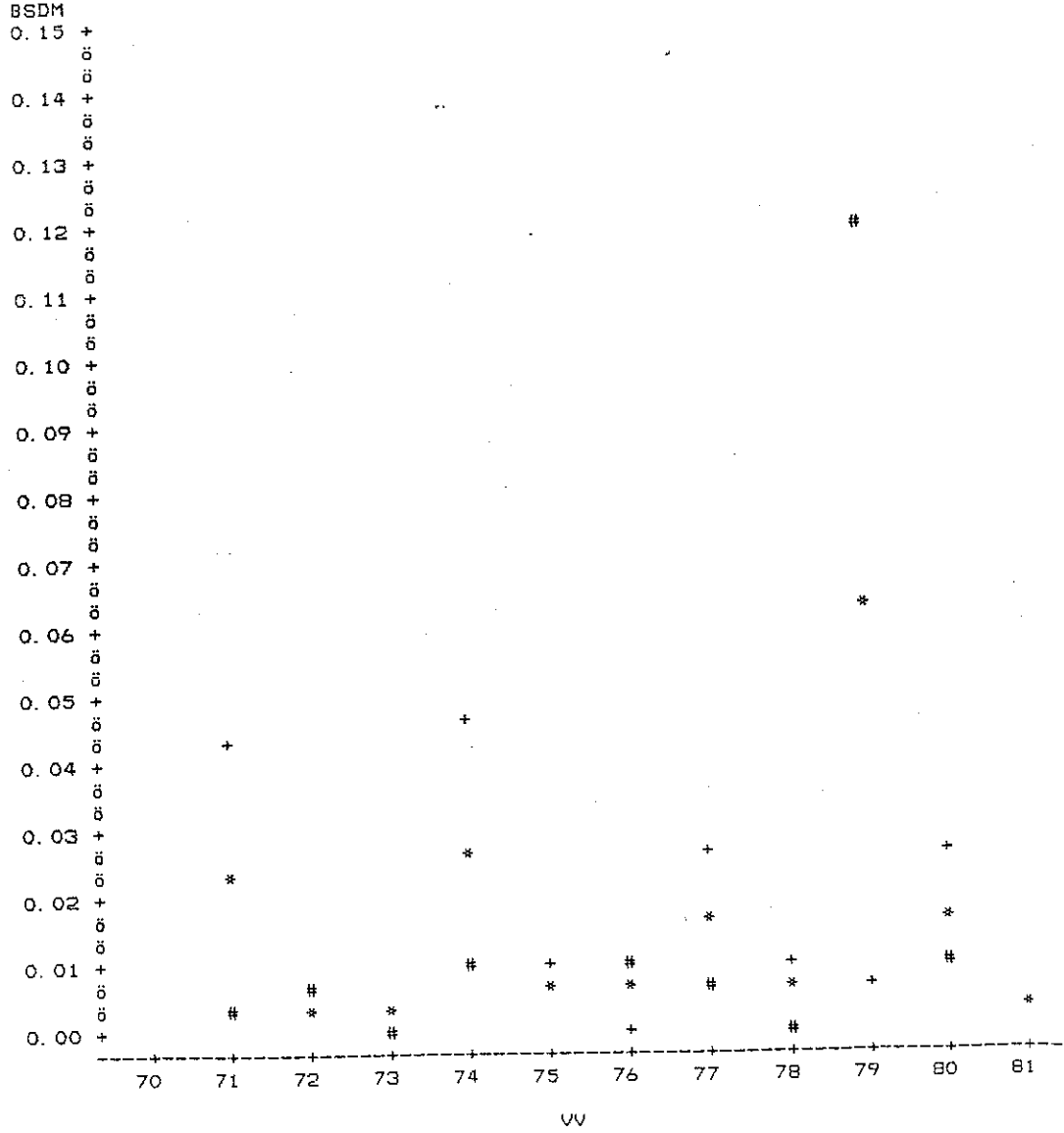


Figure 3

LIABILITIES

YRITYS=KEMI

PLOT OF P011*VV SYMBOL USED IS *
 PLOT OF P012*VV SYMBOL USED IS #
 PLOT OF P013*VV SYMBOL USED IS +

PLOT OF P021*VV SYMBOL USED IS *
 PLOT OF P022*VV SYMBOL USED IS #
 PLOT OF P023*VV SYMBOL USED IS +

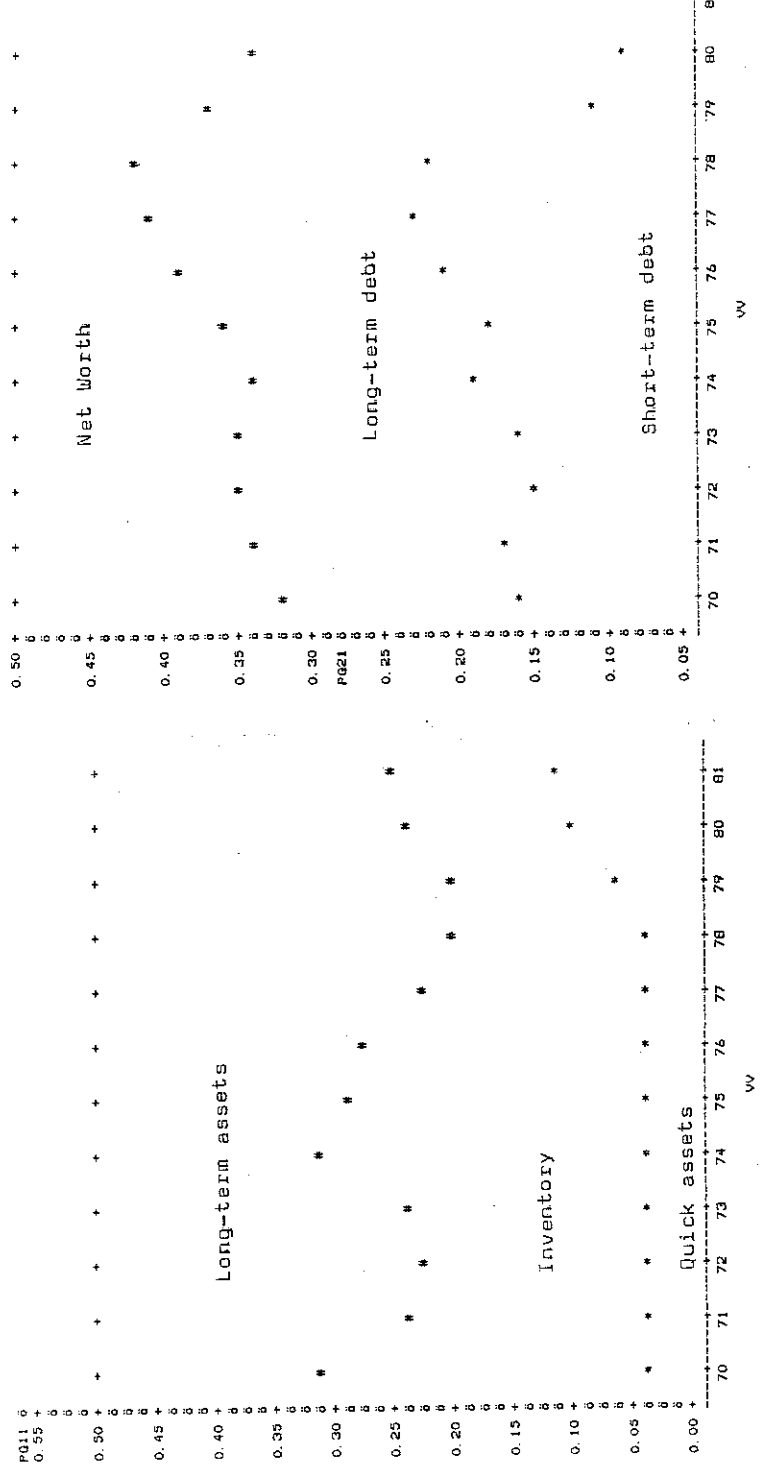


Figure 4

DECOMPOSITION MEASURES SPANNING 3 YEARS

YRITYS=QYWILH

PLOT OF BSDM*VV SYMBOL USED IS *
 PLOT OF LDM*VV SYMBOL USED IS #
 PLOT OF ADM*VV SYMBOL USED IS +

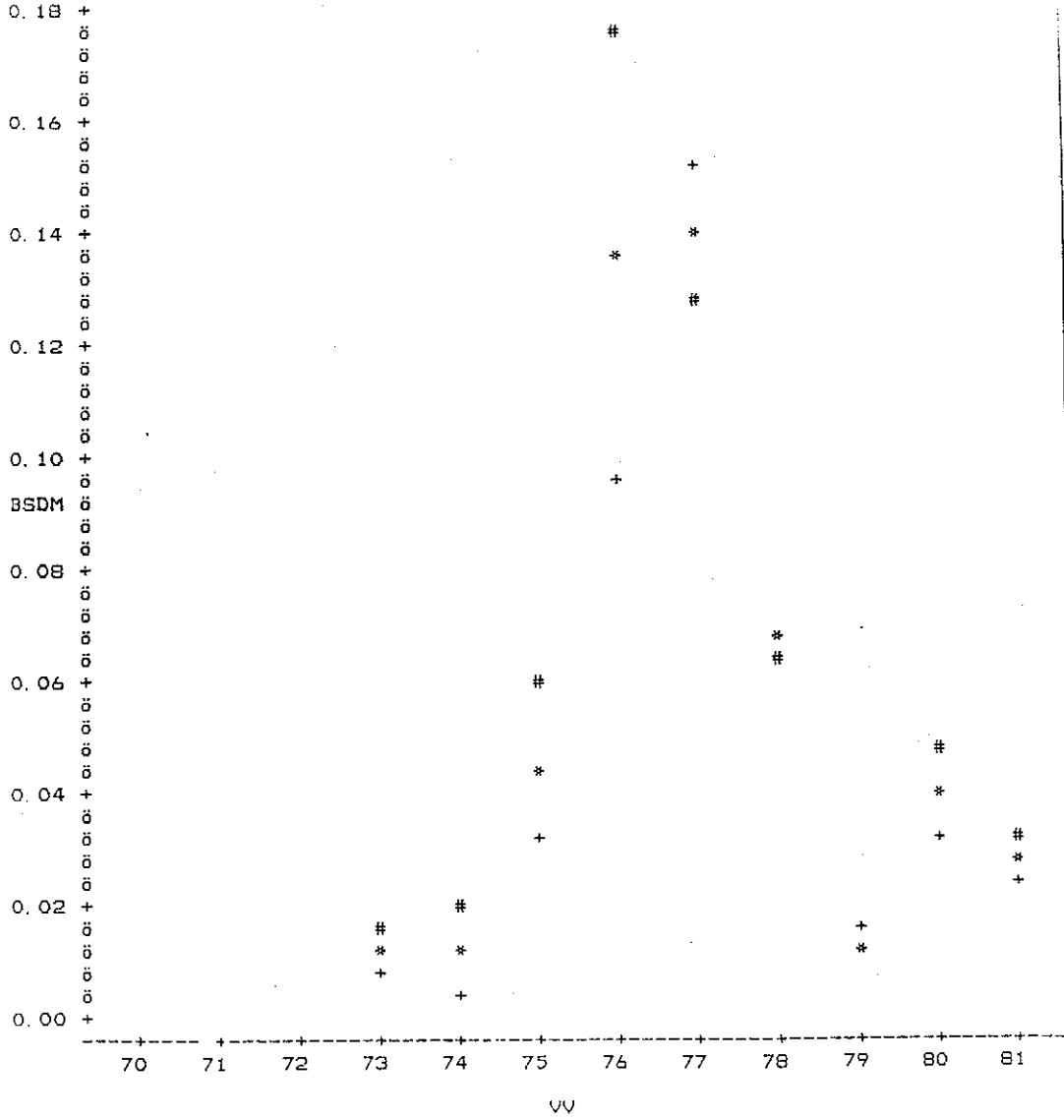


Figure 5

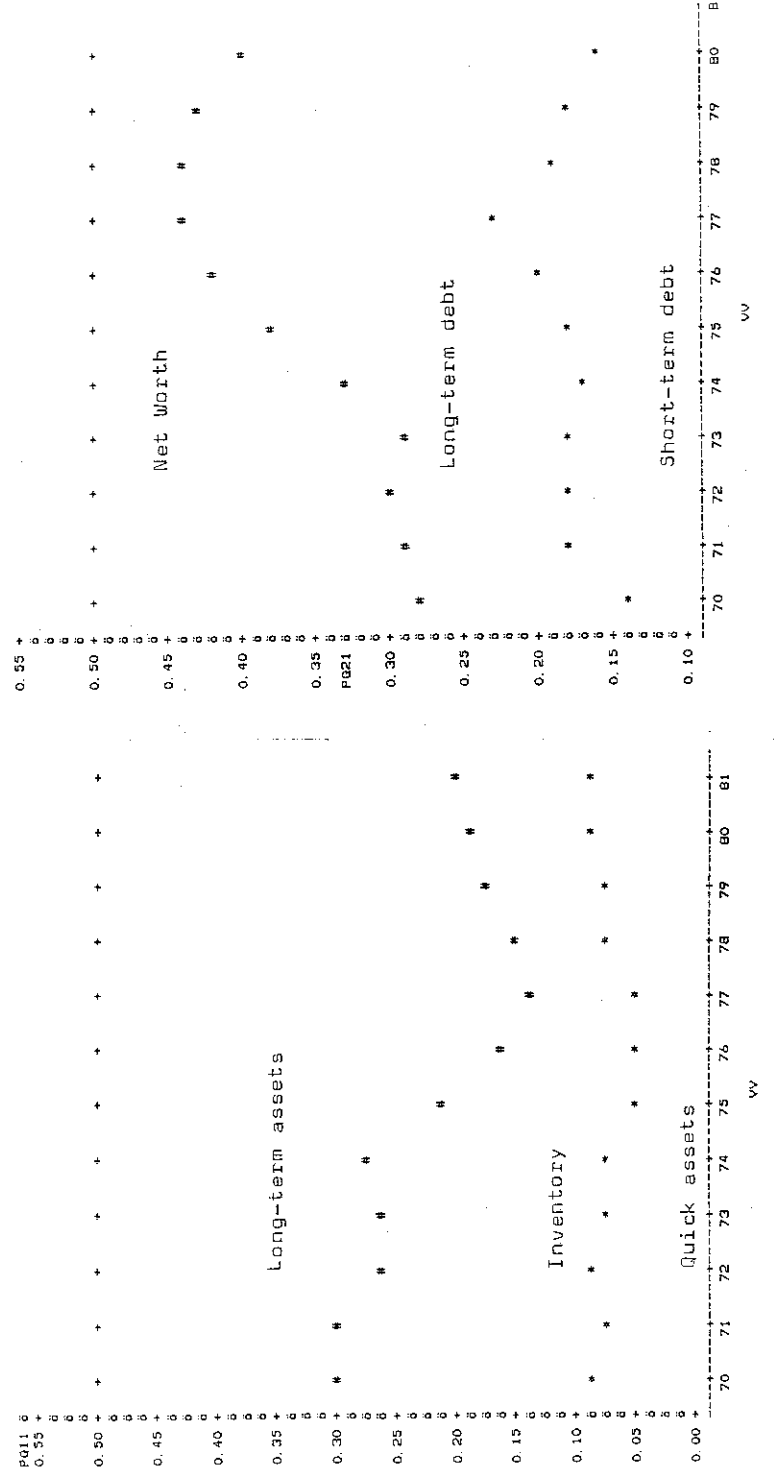
YRITYS=QYWILH

LIABILITIES

PLOT OF PQ21*VV SYMBOL USED IS *
 PLOT OF PQ22S+VV SYMBOL USED IS #
 PLOT OF PQ23S+VV SYMBOL USED IS +

ASSETS

PLOT OF PQ11*VV SYMBOL USED IS *
 PLOT OF PQ12S+VV SYMBOL USED IS #
 PLOT OF PQ13S+VV SYMBOL USED IS +



7 References

- Aho, T.(1981). Financial Statement Analysis of the Firm (in Finnish). Espoo: Otakustantamo.
- Astola, J & Virtanen, I.(1981). Entropy correlation coefficient, a measure of statistical dependence for categorized data. Research report, Lappeenrannan teknillinen korkeakoulu.
- Ball, R & Lev, B & Watts, R.(1976). Income variation and balance sheet compositions. Journal of Accounting Research 14:1, 1-9.
- Belkaoui, A.(1976). The Entropy Law, Information Decomposition and Corporate Takeover. Journal of Business Finance & Accounting 3:3, 41-52.
- Hauser, J.(1978). Testing the Accuracy, Usefulness and Significance of Probabilistic Choice Models: An Information-Theoretic Approach. Operations Research 26:3, 406-421.
- Kullback, S.(1966). Information Theory and Statistics. New York, Toronto, London; Dover Publications, Inc
- Latosaari, E & Virtanen I.(1983). Entropy as a Measure of Homogeneity in Categorical Grouping Analysis (in Finnish, summary in English). Proceedings of the University of Vaasa. Research Papers No 96.
- Lev, B.(1974). Financial Statement Analysis. Englewood Cliffs: Prentice Hall, Inc.
- Theil, H.(1969). On the Use of Information Theory Concepts in the Analysis of Financial Statements. Management Science 15:9, 459-480.
- Walker, M & Stowe, J & Moriarty, S.(1979). Decomposition Analysis of Financial Statements. Journal of Business, Finance & Accounting 6:2, 173-186.