

AN EMPIRICAL ANALYSIS OF USEFUL FINANCIAL RATIOS: AN EXPLORATORY STUDY OF IRISH PUBLIC QUOTED COMPANIES

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Introduction

Financial ratios have played an important part in evaluating the financial position and performance of business entities for many years. Their importance is explained by Laurent (1979), who says:—

“there are certain normative relationships existing between the different financial components of a company as displayed in the balance sheet and revenue and appropriation account. The extent to which a company does, or does not, conform to these norms for the activities (industry) that it is engaged in is indicative of something, depending on the relationship being examined, as is any trend over time around the prescribed norm”

However, as Chen and Shimerda (1981) note, there is one recurring question with the use of financial ratios: which ratios, among the hundreds that can be computed easily from the available financial data, should be analysed to obtain the information for the task in hand? Conceivably, all financial ratios cannot be equally important in a multi-ratio model. Discrimination is needed to identify a limited set of accounting ratios.

In the absence of discrimination, three potential problems can be created. First, the large number of ratios may generate ambiguity. As Pinches, Mingo and Caruthers (PMC 1973) argue, the user will classify ratios into groups, and choose one ratio from each group, in the hope that the small subset of financial ratios will adequately describe the characteristics of the firms under study. Yet different users may employ different ratios even when used for the same purpose which, in turn, creates a comparability problem. For example, return on shareholders funds may be calculated on a pre-tax or post-tax basis in addition to using opening, closing or average values. This has the potential to create some ambiguity, especially if the construction is not properly explained and the consequent comparison of

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results may not be necessarily valid. Secondly, some ratios may be overlooked in the analysis even though they provide a rich source of information about the company. For example, analysts will probably calculate the same ratios for a company for successive accounting periods in order to identify any significant trends. Consequently, the analyst may be reluctant to introduce new ratios into his decision model. Finally, and perhaps more important is that extracting a comprehensive set of ratios may not be efficient as a means of analysis. Because of the commonality of the financial data used in the various ratios, there will be strong overlapping between these ratios. Jackendoff (1962) demonstrates this overlapping:

“Another type of redundancy arises from the use of ratios which are easily derived from one another. One of the most obvious sets of such related ratios includes:

1. *Net worth to total debt (or its inverse, total debt to net worth)*
2. *Net worth to total assets*
3. *Total debt to total assets*

They are simply variants of the equation:

$$\textit{Total assets} = \textit{Total debt} + \textit{Net worth}''$$

The purpose of this research is to identify a small, critical set of independent financial ratios or measures which contain most, if not all, of the information in a relatively complete set of accounting ratios. Such a sub-set of financial ratios would make general financial statement analysis more efficient in the context of forming a view of a company's overall financial position. Other researchers, mainly in the USA have collapsed large sets of ratios into a much smaller number of underlying financial structures which retain most of the information contained in the original data. However, no evidence is available for Ireland.

This paper is divided into four sections: Section 1 outlines the research design. Section 2 describes the research methodology. The results and their interpretation are contained in Section 3. The conclusion is presented in Section 4 together with the limitations of the research and suggestions for future research.

Research Design

The data used was extracted from the published annual financial statements of Irish companies. The sample was based on The Irish Stock Exchange Official List, dated 25th August, 1988. The companies chosen met the following three criteria:—

- (a) are involved in activities other than finance, investment or exploration; and

- (b) whose ordinary shares had a full quotation on the Irish Stock Exchange. Thus, companies quoted under Rule 535 (i.e. the Unlisted Securities Market — USM) were excluded; and
- (c) had published annual financial statements during the twelve months ending 30 September, 1988.

The requirement that the company should not be involved in finance, investment or exploration activities was established because of the essentially different nature of such companies and hence, the inadvisability of comparing them with general industrial concerns. Requirement (b) was imposed to concentrate on those shares which carry a greater “risk” of investment and are frequently traded on the Irish Stock Exchange. Requirement (c) imposed a time boundary which is necessary in all research activities. In total, twenty-eight companies met these three criteria.

To satisfy the objectives of this research, it was important that the initial set of financial ratios be as complete as possible in the sense of covering the major dimensions of company performance and financial position.

Ideally, the financial ratios should be selected on some theoretical basis, coupled with demonstrated empirical evidence of their usefulness. One theoretical foundation for the selection of ratios has been developed by Pares (1980). Basically, Pares extended and refined the well-known Du Pont system of financial analysis to include the effects of leverage and taxation.

The Du Pont formula basically relates profitability on total assets (defined as profit before interest and tax [PBIT] divided by total assets) to two factors namely, profitability on sales and total asset utilisation.

Thus:—

$$\text{ROTA (Return on total assets)} = \frac{\text{PBIT}}{\text{SALES}} \times \frac{\text{SALES}}{\text{TOTAL ASSETS}}$$

Pares shows how the above ROTA model can be converted to reflect the after — tax Return on Shareholders Funds (ROSF) as follows:

$$\begin{aligned} \text{ROSF} &= \frac{\text{PBIT}}{\text{SALES}} \times \frac{\text{SALES}}{\text{TOTAL ASSETS}} \times \frac{\text{TOTAL ASSETS}}{\text{SH. FUNDS}} \times \frac{\text{PBT}}{\text{PBIT}} \times \frac{\text{PAT}}{\text{PBT}} \\ &\quad \quad \quad (a) \qquad \quad \quad (b) \qquad \quad \quad (c) \qquad \quad \quad (d) \qquad \quad (e) \\ &= \frac{\text{PAT}}{\text{SHAREHOLDERS FUNDS}} \end{aligned}$$

PBIT = Profit before interest and tax

PBT = Profit before tax

PAT = After tax profit

Thus, according to Pares, the five factors that explain ROSF are:—

- (a) Profit margin on sales which includes both revenues affected by commercial policies and cost of sales due to marketing, production and administrative efficiency.
- (b) Total asset turnover which indicates general efficiency in asset use as well as sales volume.
- (c) Solvency which indicates the relationship between total assets and total shareholders funds.
- (d) Income gearing which indicates the impact of gearing (i.e. interest) on pre-tax earnings available for shareholders.
- (e) Burden of corporation tax.

Pares' framework allows one to extract 11 commonly used accounting ratios, including three overall measures of profitability viz., Return on Total Assets (ROTA) and either pre-tax or post-tax return on shareholders funds.

However, it was decided to expand the set of ratios to include dimensions such as BALANCE SHEET GEARING, LIQUIDITY, OVER-TRADING, CREDIT RECEIVED and DIVIDEND POLICY. These five additional dimensions are cited in well known texts on financial management as being important in analysing the financial statements of an entity (Van Horne, 1986; Brearly and Myers, 1988).

However, the number of companies (observations) constrained the number of ratios which could be used. Using the statistical technique of principal components factor analysis, it would not be appropriate to have more variables (ratios) than observations (companies). Consequently, it was decided to expand the number of financial ratios to 28, which corresponded to the number of companies in the sample. The additional 17 ratios were selected on a subjective basis rather than on the basis of popularity in the literature or such as advice from financial analysts.

The complete set of ratios (and average values) are listed in Table 1.

Log transformations were not applied to any of the ratios for the following reasons. First, principal components analysis involves no distributional assumptions. Consequently, no transformations are needed. Second, as no decision model is employed in this paper, there is no specification of the form the variables must take. Third, it is often difficult to determine the transformation to be applied. Ad hoc choice of transformation methods can introduce an element of bias in the results. Finally, many decision makers and researchers make use of data in their raw form.

Table 1: *Financial Ratios Used**Grouped According to which Aspect of the Entity they Measure*

	MEAN
RETURN ON INVESTMENT	
1. Pre-tax return on shareholders funds (PBT/SF)	17.1%
2. Post-tax return on shareholders funds (PAT/SF)	10.6%
3. Return on total assets (PBIT/TA)	9.5%
4. Return on capital employed (PBIT/SF + LTD)	14.7%
ASSET/INVESTMENT TURNOVER	
5. Total asset turnover (SALES/TA)	1.36
6. Fixed assets turnover (SALES/FA)	5.11
MANAGEMENT OF DEBTORS	
7. Debtor days [(Debtors/Sales) × 365]	62 days
STOCK MANAGEMENT	
8. Stock turnover days [(Stock/sales) $\frac{1}{8}$ 365]	65 days
CREDIT RECEIVED	
9. Days credit received [(Creditors/Sales) × 365]	45 days
PROFIT MARGIN	
10. Operating profit margin (PBIT/SALES)	8.4%
11. Pre-tax margin (PBT/SALES)	6.6%
12. After-tax margin (PAT/SALES)	5.0%
TAX MANAGEMENT	
13. Corporation tax burden (PAT/PBT)	80.4%
DIVIDEND POLICY	
14. Dividend payout (DIVS/PAT)	12.8%
SOLVENCY	
15. Total assets financed by shareholders funds (TA/SF)	2.19
16. Total assets financed by long term debt (TA/LTD)	282.14
BALANCE SHEET GEARING/LEVERAGE	
17. Long term Debt/Equity ratio (LTD/SF)	31.7%
18. Long term debt/Capital employed ratio (LTD/CE)	19.6%
19. Total debt to shareholders funds (TD/SF)	119.5%
INCOME GEARING/LEVERAGE	
20. Burden of interest (PBI/PBIT)	67.5%
21. Interest cover (PBIT/INTEREST) times	42.2
LIQUIDITY	
22. Current ratio (CA/CL) times	1.63
23. Acid test ratio (CA-Stock/CL) times	1.03
OVERTRADING	
24. Working capital turnover (SALES/WC)	7.80
25. Turnover of shareholders funds (SALES/SF)	3.02
26. Stock levels (Stock/Current assets) × 100	39.1%
27. Current asset level (CA/TA)	53.0%
28. Fixed assets financed by shareholders funds (FA/SF)	0.79

Research Methodology — Principal Components Factor Analysis

The research methodology used was that of Principal Components Factor Analysis. This statistical technique will group variables into a few factors that return a maximum of information contained in the original variable set. A satisfactory solution will yield factors which convey all essential information of the original set of variables. In other words, principal components factor analysis provides a parsimonious description of

observed data and allows one to determine, from the total set of twenty-eight financial accounting ratios listed in Table 1, a smaller set of independent factors which account for most of the variance (and hence information) contained in the original set:

The first step in this representation is computation of correlation coefficients for all pairs of variables in the data set. This matrix of correlation coefficients is then manipulated to produce a subset of original data that retains the maximum amount of information contained in the original data set. Variables within this subset are called factors. Principal Components uses an orthogonal rotation of the initial factor pattern and thus, produces rotated factors which are linearly independent and orthogonal.

In theory, there may be as many factors as original variables. However, the researchers, consistent with the objective of factor analysis, will want to employ only those factors that contribute substantially to explaining variation in the original data set. Other factors are disregarded. The number of principal components to be extracted is normally based on Kaiser's criterion. The application of this decision rule is simple: only principal components having latent roots (eigenvalues) greater than one are considered as essential, and should be retained in the analysis. Principal components with low eigenvalues (less than one) are eliminated.

Applying Principal Component Analysis to the twenty-eight financial accounting ratios, it was determined that six factors accounted for 83% of the total variance in the original twenty-eight financial accounting ratios. At five factors the variance accounted for 76% and at seven factors the variance amounted to 87%. Thereafter, the additional variance accounted for by the marginal factors was quite small (about two per cent) and the eight factor had an eigenvalue of less than one.

The desirable number of factors is, therefore, between four and seven and the criterion for selecting from within that range was interpretability of the resulting factors. That is, the extent to which the nature of the individual factors could be readily identified. In addition, a high percentage variance was deemed desirable.

The six factor solution was the one found to be most interpretable, and hence, the one adopted in this study. The six factor solution accounts for 83.0% of the total variance in the original twenty-eight financial accounting ratios.

Interpretation of Results

Having determined the factor solution to be used, it is now necessary to

658.1502854
1512.740
58.

- (i) identify the underlying dimension that each factor represents and,
- (ii) make these factors operational so that they can easily be applied in analysing financial statements.

One of the difficulties of using Principal Component Analysis is that the researcher must interpret what each of the resulting factors represents in terms of original data. Each factor is a linear combination of the original twenty-eight financial accounting ratios and is orthogonal (and hence independent) to all other factors. As such, it may not have an obvious meaning. It is, therefore, necessary for the researcher to examine the loading of the individual variables (in this case the financial accounting ratios) on each factor and identify any commonality and hence, the meaning in those variables (financial ratios) which have a high loading on an individual factor and hence, substantially determine its value (factor score). The financial ratios which achieved a high factor loading on each factor, and the actual factor loading, are given in Table 2 and the conclusions reached as to what each factor represents are given below.

Table 2: *Summary of Financial Ratios with High Loading on Each Factor*

Ratio	Financial Ratio	Factor Loading
FACTOR 1		
1.	Pre-tax return on shareholders funds	.91809
2.	Post-tax return on shareholders funds	.93335
3.	Return on total assets	.94793
4.	Return on capital employed	.90132
10.	Operating profit margin	.86770
11.	Pre-tax margin	.90489
12.	After-tax margin	.90684
FACTOR 2		
15.	Total assets financed by shareholders funds	.92711
17.	Long term debt/equity ratio	.88233
18.	Long term debt/Capital employed ratio	.86372
19.	Total debt related to shareholders funds	.92712
FACTOR 3		
5.	Total asset turnover	.85718
24.	Working capital turnover	.70281
25.	Turnover of shareholders funds	.83940
FACTOR 4		
28.	Fixed assets financed by shareholders funds	-.86706
27.	Current asset level	.86677
FACTOR 5		
7.	Debtor days	.79050
23.	Acid test ratio	.83770
FACTOR 6		
9.	Credit days received	-.80215
13.	Corporation tax burden	.75052
14.	Dividend cover	.60122

Factor 1

The financial accounting ratios with a high loading on this factor are concerned with overall return on investment and profit margin on sales. To have two different ratio categories under this factor does not create an interpretation problem. Rather it acknowledges the interdependencies of ratios which in this case means that the higher the profit margin in sales, the higher will be the return on investment.

Factors 2

Three ratios under this factor are concerned with the gearing or leverage effect and in particular the amount of shareholders funds in existence at balance sheet date.

Factor 3

These ratios are concerned with turnover of investment (being defined in terms of either total assets or shareholders funds) and overtrading (sales/working capital). The two dimensions are interlinked in the sense that a higher turnover level MAY be indicative of overtrading.

Factor 4

Both of these factors are concerned with overtrading. Typically, a business that is overtrading will have a small amount of shareholders funds. If investment in fixed assets is high then, this will place inevitable cash flow problems on the company. In addition, a business that is overtrading can be characterised as having larger amounts of stocks and debtors, i.e. current assets.

Factors 5

These ratios provide an indication of the liquidity of the company. The acid test ratio is well known as a measure of liquidity while generous credit terms allowed to customers can cause liquidity problems.

Factors 6

The three different ratios under this heading refer to different dimensions of financial statement analysis. This confusing pattern is to be expected since this final factor accounts for only 7% of the overall variance. This factor is interpreted as measuring the amount of credit received by a firm.

In summary, the six factors were identified to measure the following aspects of the business:—

- Factor 1 Return on investment
- Factor 2 Gearing/Leverage
- Factor 3 Utilisation of total assets
- Factor 4 Overtrading
- Factor 5 Liquidity
- Factor 6 Credit days received

Making the Factors Operational

Given that the six factors account for 83.0% of the total variance in the original twenty-eight financial ratios, the use of these six FACTORS could improve the efficiency of financial ratio analysis.

Perhaps the simplest way to apply these Factors to the analysis of financial statements is to find surrogate measures for each of the six factors (or dimensions) identified by the principal component analysis. These surrogate measures must retain the qualities of the six factors, that is, independence and a high explained variance. In addition, they must be meaningful accounting ratios. Thus, the ratios must satisfy the following criteria.

- (i) are highly correlated with the factor that they represent
- (ii) are independent of each other
- (iii) are in generally accepted usage

To identify these financial ratios, the "choice-set" for each factor was those financial ratios which had a high rating on that factor, (preferably greater than .90). From this was selected that financial ratio which was most independent from the remaining ratios scoring high on the other five factors.

The set selected, based on judgement, is that given in Table 3. To the right of each financial ratio is given the correlation coefficient (r) between it and the factor that it represents.

Table 3: *Financial Accounting Ratios Selected to Represent Each Factor*

Factor	Underlying dimension	Ratio	Correlation
1.	Return on investment	ROTA = PBIT/TA	.94793
2.	Gearing/Leverage	TOTAL DEBT/S. FUNDS	.92712
3.	Utilisation of total assets	SALES/TOTAL ASSETS	.85718
4.	Overtrading	FIXED ASSETS/S. FUNDS	-.86706
5.	Liquidity	(CA — STOCK)/CL	.83770
6.	Credit received (days)	CREDS/SALES × 365	-.80215
Mean r =			.87319

As can be seen, these are high (average .87) which indicates that the six financial ratios (surrogate measures) explain 72% of the variance (and hence, information) contained in the original twenty eight financial ratios listed in Table 1. Thus, the additional loss of information in using these six ratios rather than the six factors is 11%. This is a very small loss and can justify the use of individual ratios rather than the six identified factors.

It is interesting to make comparisons between the above results and major studies in other countries that have employed the technique of principal component analysis. Laurent (1979), based on Hong Kong data, extracted 10 factors which explained 80% of the variance in the original data set of 45 ratios. Pinches et al. (1973) identified 7 factors which accounted for 91% of the variance in a sample of 221 US companies. Ezzamel et al. (1987) extracted 10 factors in a recent UK study, although their classification of factors is ambiguous. The results of these analyses are summarised in Table 4 and they represent a large degree of agreement.

In all the studies, the number of variables was significantly reduced from the original set of variables, yet the reduced set of ratios still accounted for the majority of the variance contained in the original set of financial ratios. Any disparity between these studies could be attributed to differences in sample sizes, numbers and types of ratios used and limitations imposed on the number of factors to be extracted.

Table 4: *Comparison of Principal Components Analysis on Financial Ratios*

	CLARKE	LAURENT	PMC	EZZAMEL et al.
	1989	1979	1973	1987
Country	Ireland	Hong Kong	USA	UK
No. of factors	6	10	7	10
Percentage variance	83%	80%	91%	76%
Financial Dimension, Ratio Ranking and Construction				
Return on investment	1 ROTA	1 ROTA	1 ROSF	2 CF/TA
Gearing	2 TD/SF	2 LTD/TA	4 DEBT/ EQUITY	1 T.DEBT/ EQUITY
Asset utilisation	3 SALES/TA	4 SALES/FA	2 SALES/FA	6 CF/SALES
Overtrading	4 FA/SF	3 SALES/ WC	N/A	3 T.DEBT/ WC
Liquidity	5 QA/CL	6 QA/CL	10 QA/CL	
Credit terms	6 CREDS/ SALES	10 DBTRS/ SALES	5 DBTRS/ SALES	N/A

Conclusion and Suggestions for Further Research

This exploratory research was intended to assess the feasibility of applying principal components factor analysis to accounting ratios of Irish companies. In particular, it sought to identify a small set of financial ratios which, in an Irish context, would:—

- (a) account for a significant proportion of the total variance in a (relatively) complete set of financial accounting ratios, and thus,

provide most of the information that would be available from a more comprehensive and detailed analysis; and

- (b) are sufficiently few in number to increase the efficiency of financial statement analysis using ratio analysis;

The results of this exploratory research indicate that the financial analyst can confine his analysis of the firm's OVERALL financial position and performance to six financial ratios with the assurance that they are relatively complete in terms of coverage and information. By having only a few (six) ratios, the analyst should be in a better position to comprehend the total financial picture of a business entity compared with the computation of a much larger set of ratios.

The limitations of this research must be acknowledged. Before firm conclusions can be drawn, it will be necessary to apply the methodology to a larger number of companies and this would permit a larger number of ratios to be used. Principal components is variable-sensitive, different factors may be obtained if different sets of variables (ratios) are fed into the principal components analysis.

It would be possible to introduce additional ratios to cover different dimensions of performance and position. For example, ratios on cash flow could usefully be added, since it is now acknowledged that the objectives of financial reporting indicate that users need information about cash inflows and outflows to help with assessments of future cash flows and to provide feed back about previous assessments (FASB, 1980). Based on the proposition that profitability differs conceptually from cash flow, one could hypothesise the presence of a separate cash-flow factor. As Gombola et al. (1983) found, cash flow measures represented a dimension of firm performance and so cash flow ratios should not be overlooked in descriptive studies involving financial ratios.

Indeed, it would be interesting to compute ratios on three different accounting bases, namely, historic cost, current cost, and general price level accounting and compare the results. If the results using all three bases were not significantly different, it might suggest that price adjusted accounting ratios (and thus, financial statements) have little additional information content compared with the traditional, historic cost statements.

The question of which ratio should represent a particular factor needs greater scrutiny. The procedure adopted of selecting the ratio with a high absolute factor loading makes the selection sensitive to the sample of ratios initially chosen.

Future research could investigate the stability of financial patterns over time and/or over different industrial groupings. Much of the benefits of this research would be eroded if patterns underlying financial ratios are not stable over time. For example, Johnson (1978) found that his computation of factor pattern was remarkably stable across two industrial classifications in the USA.

These preliminary results may be of value to researchers wishing to establish relationships between the financial state of a company and some possible outcome (for example bankruptcy). Research, such as conducted by Beaver (1965) and Altman (1968) almost by definition, use multivariate analysis and require the use of only those financial accounting ratios which are relatively independent of each other, if their individual effects are to be properly identified. This paper indicates that the above set of six ratios, not only are independent of each other, but are also relatively complete in the coverage of a firm's financial profile. Thus, the researcher would be able to justify the use of them in terms of completeness of coverage of the financial profile of a firm and independence, rather than having to arbitrarily select financial ratios which are relatively independent and appear to cover all relevant financial aspects of the firm.

Finally, no behavioural analysis of decision makers was made in this study. It would be a valuable piece of research to identify the financial ratios used by decision makers in analysing financial statements. After all, accounting should seek to satisfy the information needs of users. However, this approach creates a potentially difficult problem for accountants, if they discover that users are not using the "right type" of accounting information in their decisions. There is, in such circumstances, an "educative" role for accountants. This brings one back to the fundamental purpose of accounting, which is that of influencing human behaviour and of which, ratio analysis, is but one part of that process!

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