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This paper reviews two models for testing the financial security of construction companies. It discusses the utility of the ratio analysis technique and the *Z* model in predicting whether companies are heading for insolvency. It then applies these techniques to three construction companies which failed within the last 5 years to test whether the theoretical predictions prescribed in the techniques are applicable to the construction industry. It concludes that whilst the techniques are of value in predicting some difficulties they need to be used in conjunction with financial performance data of other construction firms, in this way comparisons may be made. The development of a refined and construction specific *Z* model is recommended.

Keywords: Insolvency, ratio analysis, *Z* model, financial performance.

Introduction

Insolvency is not a new phenomenon in the construction industry but the economic depression of the past 2 years has caused an increase in the number of companies experiencing insolvency. Therefore, it is timely for methods of early detection of insolvency to be explored and applied when necessary.

As Mason and Harris (1979) point out 'construction is recognized as a high risk business. Whilst the smaller firms have always been considered as a potential risk, the larger companies were regarded as being reasonably secure.' However, in the current economic climate many big firms are known to have trimmed their scope of operations and operating costs in order to avert insolvency.

The size of the problem is well documented. It should be noted that bankruptcy is a term pertaining to individuals whereas, insolvency is a broader term incorporating liquidation, receivership and administration of a company by bankers or others with a financial stake. The Annual Abstract of Statistics (HMSO, 1990) records that in the period 1978–88, liquidations associated with the construction industry amounted to 14% of all liquidations. However, to this figure needs to be added the number of self-employed, a typical business arrangement for construction operations, who have gone bankrupt. The Annual Abstract of Statistics summarizes the picture for 1988 (Table 1).

Table 1 Bankruptices in construction operations, 1988

Bankruptcies and deeds of arrangements	No.
Total bankruptcies	7728
Number of whom were self employed	5601
Number involved in construction	1590 – 28% of those going bankrupt, are involved in construction
Company insolvencies in construction	1471 – 16% of total
Total	9427

The figures reflect a period when trading conditions were good and the recession beginning in 1989 resulted in a harsher economic environment and hence greater number of bankruptcies.

These figures represent the largest proportion of firms going insolvent in any industrial sector. Mason and Harris (1979) note that 'the resultant damage from insolvency goes beyond the obvious and quantifiable costs to the owners, creditors and employees of a company. There are second-order costs which must be borne by the community at large'. This is particularly so for public sector construction activity. Whilst the balance of construction workload has changed dramatically over the period of 1980–1990, with public sector

activity sharply declining when compared to private sector output, it (the public sector) still awards over £4000 m of new work each year. This represents, according to the Housing and Construction Statistics (1990), some 23.8% of the output of new work. In the repair and maintenance (R&M) sector, over half of the non-housing R&M is carried out in the public sector. Expansion of this sector is predicted so that the backlog of R&M work in the public sector building stock can be tackled.

Against this backlog, the existence of some mechanism for selecting contractors who are financially secure needs to be developed.

In 1979 Mason and Harris recorded that 'the methods used to select companies for a contract seldom discriminate between solvent and potentially insolvent companies'. This position is unchanged some 12 years on. In the public sector the state agencies are seeking to reduce government spending and derive the maximum benefit from what is spent. Therefore, it is important to do everything possible to ensure that the most suitable comapnies are selected to complete government contracts. In the private sector more discretion is possible, as clients are not expected to select the lowest tender as a matter of procedure, but the need to derive maximum benefit from a construction project may be as pressing. Consequently any method which could assist in identifying companies in danger of insolvency could assist efficient use of resources dedicated to construction. This paper discusses two such methods:

1. the ratio analysis
2. the Z model

and then tests these methods on three construction companies.

The ratio analysis approach

Generally, ratio analysis should enable the analyst to look at the operating performance in terms of:

(a) whether the firm is utilizing its assets,
(b) whether its profit margins are in line with assets,
(c) whether there is excessive investment in fixed assets,
(d) whether the business is adequately financed,
(e) whether there are signs of liquidity strains,
(f) whether collection of receivables is efficient.

A full scale interfirm comparison will enable the questions to be resolved into more essential factors such as, whether production costs are higher than competitors, whether labour costs and utilization are in line with the industry's average and how overheads compare with others.

Key factors

The underlying factors which determine the profitability and solvency vary from one industry to another. For example, the factors that affect a manufacturing factory may be different from those affecting a construction firm. Most companies consist of a number of businesses, each with its individual characteristics. Each must be subdivided for purposes of financial analysis. For example, a construction firm may have a Building and Civil Engineering division and a Property and Estate Agency division each with its own distinct operating company; each need to be compared with the appropriate industry sector.

In essence, ratio analysis compares pertinent ratios of a business with other firms in the same business. Some ratios were shown to indicate a serious weakness in a company several years in advance of failure. The idea was that, for example, if current assets more than cover current liabilities, then this is a sign of strength. The lower the cover, the greater the weakness. The extremes could readily be identified and a cut-off range or point could be established from predictive experience. Freear (1985) published ratios which appeared to be useful predictors as studied by various authors. The predictor ratios are as follows.

1. Liquid assets ratio (two studies), obtained by dividing current assets by current liabilities.
2. Acid test ratio (two studies), is a ratio of current assets less inventories to current liabilities.
3. Net worth to fixed assets (five studies), obtained by dividing total assets less total liabilities by fixed assets.
4. Working capital to total assests (five studies), obtained by dividing current assets less current liabilities by total assets.
5. Net profit to net worth (three studies), obtained by dividing net profit by total assets less total liabilities.
6. Net worth to total liabilities, obtained by dividing total assets less total liabilities by total liabilities.

The first two concentrated on the short term position, measuring the company's ability to meet short term liabilities. The other measures concentrated more on the overall long term and short term position of the company, they incorporate total assets and total liabilities in one form or the other. The fifth ratio is incorporated as an income measure.

Tamari (1964) observed that a large proportion of successful companies have at least one weak ratio, some two or three. He concluded that an analyst cannot rely

on one ratio alone, this is particularly so in construction companies. Mason and Harris (1979) using discriminant analysis for 40 failed and non-failed companies in the UK, found six ratios that produced high discriminating powers. These are as follows.

1. Profitability measured by profit to assets.
2. Profitability measured by profit to capital.
3. Working capital position, which is the ratio of debtors to creditors.
4. Financial leverage, which is the ratio of current liabilities to current assets.
5. Quick asset position which is equal to the logarithm to base ten of the age of debt.

Interpretation of ratios

If the performance of a business, as measured by its ratios is compared with industry's average over a long period of time, it will show a trend. This may be a divergence from the industry's average indicating areas worthy of attention by the managers of the company.

These ratios have meaning and point to how the company was run in the year of accounts or earlier. It should be pointed out that ratios are indicators of past events and the trend may continue if managers of the company do nothing to change the situation. This is why it is not possible to say for certain that the company will fail since what the managers, the shareholders, the creditors or others may do is not predictable. However, the indication that the firm is in trouble of one form or another will be clear.

The *Z*-model

'The method is based on the statistical technique of multivariate discriminant analysis. It has been in use for many years in the USA by government agencies, banks, investment houses, etc. to identify potential insolvencies of companies' (Mason and Harris, 1979). However, there is little evidence of the use of this technique in other countries.

Mason and Harris (1979) describe the approach which consists of

> constructing the solvency profile of a company from its published accounts and comparing it with profile of companies that are known to be financially healthy or previously insolvent. The more the company's profile resembles that of a previously insolvent firm the more likely it is to fail. Its insolvency profile is summarized in single score called the *Z*-score, which is derived from the *Z*-model. The model is constructed from a number of discriminating variables derived from the published accounts of a sample of solvent and insolvent companies. The data are then mathematically combined and a single dimension is evaluated which describes the point of separation of the two

groups of companies (failed and solvent) along a scale of solvency.'

In an earlier study, Altman (1968) used multi-discriminant analysis to predict bankruptcy. He started with 22 financial ratios and slimmed this battery to five, which when combined effectively, predicted bankruptcy. The five ratios Altman selected are shown in Table 2.

Table 2 Ratios used to predict bankruptcy

Ratio	Weighting
Working capital to total assets	0.012
Retained earnings to total assets	0.014
Earnings before interest and taxes to total assets	0.033
Market value of equity to book value of long term debt	0.006
Ratio of sales to total assets	0.999

Each of these factors were weighted in accordance with the list shown in Table 2. So for example, if a company had the following ratios:

Working capital to total assets	12.5%
Retained earnings to total assets	10%
Earnings before interest and taxes to total assets	−8% (denoting a loss)
Market value of equity to book value of long term debt	30%
Ratios of sales to total assets	2.5

(note the ratio of sales to asset is presented as a ratio, not a percentage)

then the figures would be combined such that:

$Z = (0.012) (12.5) + (0.014) (10)$
$\qquad + (0.033) (-8) + (0.006) (30) + (0.999) (2.5)$
$Z = 0.15 + 0.14 - 0.26 + 0.18 + 2.5$
$Z = 2.71$

Altman suggested a minimum score of 1.8 is required for safety. Taffler (1977) suggested that UK norms delivered a cut-off point of Z as being below -1.95.

Resultant model

After finding a set of variables that provide a high level of discrimination, the variables are then combined mathematically to produce a discriminant function of the form:

$$Z = C_0 + C_1 R_1 + C_2 R_2 + \cdots + C_n R_n$$

where Z is the Z-score, C_0 is a constant, $C_1, C_2, \ldots, C_n$ are the ratio weights, and $R_1, R_2, \ldots, R_n$ are the discriminating financial ratios.

Mason and Harris (1979) after extensive analysis in the study of six variables of a model based on 20 failed

and 20 non-failed companies in the civil engineering sector of the UK came out with the function:

$$Z = 25.4 - 51.2R_1 + 87.8R_2 - 4.8R_3 - 14.5R_4 - 9.1R_5 - 4.5R_6$$

Where R_1 is the profit before interest to net assets, R_2 is the profit before interest to capital employed, R_3 is debtors/creditors, R_4 is current liabilities/current assets, R_5 is $\log_{10}$ days debtors for year, and R_6 is the creditors trend measurement.

An inspection of the function showed that R_1 and R_2 are good discriminators while R_3 and R_6 are the least sensitive discriminators. Mason and Harris found 'that short term liquidity is less important in determining a firm's solvency that a more fundamental aspect of its earning ability'.

Interpretation of results

Usually when a model is developed a cut-off score is given below which the company is likely to fail and a range within which it is unsafe and above which it is regarded as solvent.

Mason and Harris (1979) gave their cut off point for their model of construction companies in UK as 0.00. Also, Taffler (1977) based on his model among UK companies found a cut off point of $Z = -1.95$. Although it must be noted that Taffler's work was not based upon the construction industry.

A prediction of imminent failure should be based on a company's Z-score. Although a low score on its own, is a necessary condition for failure it is not sufficient evidence. As Mason and Harris note 'unhealthy companies can recover depending on the action taken by their debenture holders' bankers and creditors. The Z-score alone cannot predict failure, but it indicates that a company has a profile similar to companies that have failed and therefore have a higher probability of failure'.

The case studies

Three construction firms which had failed within the last 4 years, were selected from the records held in Companies House and their accounts subjected to ratio analysis and the Z-model.

Case 1. Company A

Profit and loss account and statement of revenue reserves for the year ended 31st March 1988

	1988	1987
Turnover	5 488 000	44 558 927
Profit/(loss) before taxation	627 162	(831 576)
Taxation	126 000	65 000
Profit/(loss) after taxation	502 162	(766 576)
Proposed dividend	400 000	–
Retained profit/(loss)	102 162	(766 576)
Earnings per share	5 02 k	–
Statement of revenue reserves		
Retained profit/(loss) for the year	102 162	(766 576)
Revenue reserves at beginning of year	5 787 081	6 553 657
Revenue reserves at end of year	5 889 263	5 787 081

Balance Sheet for Company A as at 31st March 1988

Employment of capital				
Fixed assets		3 070 400		3 279 631
Investment		270 270		270 270
Current assets				
Stock and work in progress	9 273 762		10 588 000	
Debtors	8 074 449		17 183 460	
Bank and cash balances	263 925		2 259 125	
	17 612 136		30 030 585	
Current liabilities				
Creditors	9 479 987		18 966 120	
Taxation	(1 856 563)		(869 422)	
Unpaid dividends	51 100		51 100	
Proposed dividend	400 000		–	
Bank overdraft (secured)	1 026 819		3 684 407	
	9 101 343		21 831 205	
		8 510 793		8 199 390
		11 851 463		11 749 281
Capital employment				
Share capital		5 000 000		5 000 000
Reserves		6 851 463		6 749 281
		11 851 463		11 749 281

Ratio analysis

Liquid assets ratio
$$= (17\ 612\ 136)/(9\ 101\ 343)$$
$$= 1.94$$

Acid test ratio
$$= (17\ 612\ 136 - 9\ 273\ 762)/(9\ 101\ 343)$$
$$= 0.92$$

Net worth to fixed assets
$$= (11\ 851\ 463)/(3\ 070\ 400)$$
$$= 3.86$$

Working capital to total assets
$$= (17\ 612\ 136 - 9\ 101\ 343)/(20\ 952\ 806)$$
$$= 0.41$$

Net profit to net worth
$$= (627\ 182)/(11\ 851\ 463)$$
$$= 0.053\ (5.3\%)$$

Net worth to total liabilities
$$= (11\ 851\ 463)/(9\ 101\ 343)$$
$$= 1.3$$

Z-model

$$Z = 25.4 - 51.2R_1 + 87.8R_2 - 4.8R_3 - 14.5R_4 - 9.1R_5$$
$$R_1 = (627\ 182)/(11\ 749\ 281) = 0.053$$
$$R_2 = (627\ 182)/(11\ 749\ 281) = 0.053$$
$$R_3 = (8\ 074\ 449)/(9\ 479\ 987) = 0.852$$
$$R_4 = (9\ 101\ 343)/(17\ 612\ 136) = 0.52$$
$$R_5 = \mathrm{Log}_{10}(D_n + D_{n-1})\ (365)/(2)\ (\text{Turnover})$$
$$= (17\ 183\ 467 + 8\ 074\ 449)\ (365)/(2)\ (54\ 387\ 967)$$
$$= \mathrm{Log}_{10}(84.75) = 1.93$$
$$Z = 25.4 - 51.2(0.053) + 87.8(0.053) - 4.8(0.85) - 14.5(0.52) - 9.1(1.93) = 13.24$$

Case 2. Company B

Profit and Loss Account for the year ended 31st December 1987

	1987	1986
Turnover	253 590	19 826 40
Trading loss before exceptional items, finance charges and taxation	(5 312 535)	(7 776 413)
Exceptional items – profit on sale of plant	10 318 885	2 330 109
	5 006 350	(5 446 304)
Finance charges	(3 461 522)	(4 423 253)
Profit/(loss) before taxation	1 544 828	(9 869 557)
Taxation – capital gains tax	212 000	–
Profit/(loss) after taxation	1 332 828	(9 869 557)
Extraordinary profits – profit on sale of property	–	2 486 026
	1 332 828	(7 383 531)
Deficit balance carried forward from previous year	(11 890 101)	(4 506 570)
Deficit balance carried forward	(10 557 273)	(11 890 101)

Balance sheet for company B as at 31st December 1987

	1987	1987	1986	1986
Assets employed				
Fixed assets		12 045 392		14 612 820
Current assets	18 691 672		30 651 942	
Current liabilities	(29 100 345)		(44 960 871)	
Net current liabilities		(10 408 673)		(14 308 929)
		1 636 719		303 891
Sources of capital				
Issued share capital		7 200 000		7 200 000
Capital reserves	4 993 992		4 993 992	
Revenue reserves	(10 557 273)		(11 890 101)	
		(5 563 281)		(6 896 109)
Shareholder's funds		1 636 719		303 891

Ratio analysis		*Z-model*		
Liquid assets ratio	=0.64	R_1	=	−28.9
Acid test ratio	=0.10	R_2	=	−28.9
Net worth to fixed assets	=0.136	R_3	=	0.082
Working capital to total assets	=−0.34	R_4	=	1.56
Net profit to net worth	=−5.4	R_5	=	3.42
Net worth to total liabilities	=0.056	Z	=	−1112

Case 3. Company C

Profit and Loss Account for the year ended 31st December 1985

	1985	1984
Turnover	422 078	253 870
Cost of sales	(275 622)	(394 293)
Gross profit/(loss)	146 456	(140 423)
Distribution costs	(246 187)	(333 512)
Administrative expenses	(184 825)	(266 801)
Interest receivable and similar income	4 825	1 966
Interest payable and similar charges	(63 189)	(37 536)
Loss on ordinary activities before taxation	(342 920)	(766 308)
Taxation	–	–
Loss on ordinary activities after taxation	(342 920)	(766 308)
Extraordinary items	(3 800)	(9 993)
Loss for the financial year	(346 720)	(786 301)
Statement of retained losses		
Losses brought forward	(1 420 047)	(633 746)
Loss for the financial year	(346 720)	(786 301)
Losses at 31 December 1985	(1 766 767)	(1 420 047)

Balance sheet for Company C as at 31st December 1985

	1985	1984
Fixed assets		
Intangible assets	9319	12 063
Tangible assets	6158	52 188
	70 847	64 251
Current assets		
Stocks	164 238	104 358
Debtors	150 167	98 341
Cash at bank and in hand	39 276	10 461
	353 681	213 160
Creditors amounts falling due within one year	(424 295)	(310 458)
Net current liabilities	(70 614)	(97 298)
Total assets less current liabilities	233	(33 047)
Creditors amounts falling due after more than one year	(389 000)	(455 000)
	(388 767)	(488 047)
Capital and reserves		
Called up share capital	1 378 000	932 000
Profit and loss account	(1 766 767)	(1 420 047)
	(388 767)	(488 047)

Ratio analysis		Z-model		
Liquid assets ratio	$=0.834$	R_1	$=$	-1471.76
Acid test ratio	$=0.447$	R_2	$=$	-1471.76
Net worth to fixed assets	$=5.992$	R_3	$=$	0.35
Working capital to total assets	$=-0.083$	R_4	$=$	1.20
Net profit to net worth	$=-0.808$	R_5	$=$	2.032
Net worth to total liabilities	$=1.001$	Z	$=$	$53\,861.19$

Comments on the case studies

Ratio analysis

The liquid assets ratio for company A, is 1.94 which shows that if current assets are liquidated at about half their book value, current creditors will be paid off in full. This is generally a measure of short term solvency. It indicates the extent to which the claims of short term creditors are covered by current assets that are expected to be converted to cash in a period roughly corresponding to the maturity of claims. Companies B and C are in a worse position, (with B being the worst of all) as their current assets if converted into cash at full book value cannot pay its short term creditors.

The Acid Test ratio or Quick ratio, is also the ability to pay off the short term creditors. However, inventories or stocks of work in progress are assets which may not realize their full value in the event of liquidation. Again company A has about 1:1 ratio while company B (the worst case), has only 10% coverage. Company C has about 45% coverage.

Net Worth to fixed assets ratio is an indication of the worth of the firm to fixed assets used. Fixed assets is used to generate profit. However, a very high ratio may indicate that a company is over utilizing its assets or investing too little in fixed assets.

Working capital to total assets indicate what proportion of assets is bring used for the day-to-day running of the business. Debtors, stocks, work in progress have to be carried all the time. Whilst the amount of each of these may vary, there must always be a matching aggregate finance which can support them. A low ratio of this may make trading difficult for the company and may render it insolvent in the short term. Company A has a ratio of about 0.4, while company B and C have ratios of -0.34 and -0.083 respectively. This implies that company B and C have no working capital as their current liabilities are much more than current assets.

The net profit to net worth ratio for company A is 5.3% which shows the return on capital employed, while for company B and C are respectively -540% and -80.8%. If company B and C are to remain in business, they must generate enough profit to grow and have enough protection against increased cost or falling prices.

Finally net worth to total liabilities indicates how well the companies' excess cover is over their total liabilities. Company A has 130%, i.e. 30% over and above, while company B has only 5.6% (94.4% below) and C has 100.1% (only 0.1% over and above).

Z-score

The Z-score for company A is 13.24 which is well above the 0.00 failure cut-off point given for similar companies operating hence, it could be said to be safe. However, the same could not be said for companies B and C whose Z-scores are respectively -1112 and $-53\,861$, which is well below the cut-off point.

Conclusions

While financial ratios could be useful in raising some pertinent questions about the performance of a company and highlighting areas of attention of the managers, its utility is greatest when making inter-firm comparisons. Questions such as: how a firm utilizing its assets, or how its production costs compare with those of its competitors are tests of financial stability. Even though a company may be doing well, this comparison will show how well, or if there is room for even better performance. It is recommended that a study and data of financial ratios of construction companies (both failed and solvent) be kept over time so that a trend of the industry's Z ratio average can be made available. This will form a ready basis for evaluation of solvency and performance but cannot unravel the meaning of a company. Other means of predicting company solvency are also available. At the project level consistent cost or time overruns, delayed payments to subcontractors or suppliers, heightened claims awareness, broken loan covenants can also be sensitive discriminators in relation to the health of a company. Multiple discriminant analysis is, but one tool in the prediction process.

Indeed, the use of ratios seldom provide information about the current health of a firm since they cannot decipher the managerial actions being taken. They measure a static position and do not account for the dynamism of managerial bahaviour in shaping alternative strategies. These alternatives may be as diverse as

mergers or debt rescheduling etc. Ratio analysis acts as the dipstick of financial health rather than a thorough inspection.

Nonetheless, the Z-model can, according to Freear, measure 'the extent to which a firm's policies and problems have resulted in poor performance'. Consequently, Z models should be developed to assist in assessing construction companies. The single score which is provided by the Z-model can give a global view of the performance of the company and pinpoint potential problems.

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