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A PRELIMINARY INVESTIGATION OF THE USE OF A BANKRUPTCY INDICATOR IN A SIMULATION ENVIRONMENT

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ABSTRACT

The purpose of this study was to investigate the usefulness of a widely accepted and used real-world bankruptcy indicator in a simulation environment. Two years of simulation data from a business policy class were analyzed using the bankruptcy indicator. The results of the analysis indicate that the bankruptcy indicator has application in simulation environments The results of the study also suggest that further research is needed concerning the ways in which the bankruptcy indicator may be used in simulations.

INTRODUCTION

Any instructor who has used a general management simulation in the business policy course has had firms perform poorly. In some cases the performance may be so poor that the firm should be declared bankrupt under one of two conditions: (1) technical insolvency, or (2) insolvency in bankruptcy. Under technical insolvency a firm is unable to meet its debt obligations as they occur. While the firm's assets may exceed its liabilities, which indicates a positive net worth, it lacks the liquidity to meet its debts as they come due. In insolvency in bankruptcy a firm's "liabilities are greater than the fair market value of its assets, which means a negative net worth.' (Petty. Keown. Scott, and Martin.1993, p. 826).

Simulations appear to avoid the technical insolvency issue by automatically providing funds to firms, which have inadequate liquidity. Thus firms are not forced to consider voluntary bankruptcy nor forced into involuntary bankruptcy. Under either voluntary or involuntary bankruptcy the firm could reorganize (Chapter 11 of the U. S. Bankruptcy Code) or liquidate (Chapter 7 of the U.S. Bankruptcy Code). Generally under conditions of technical insolvency firms in the real world would file for Chapter 11 bankruptcy and reorganize.

It also appears that simulations do not address the issue of insolvency in bankruptcy. Simulations continue to operate even if a firm's accumulated retained earnings are negative to such an extent that they exceed paid in capital. In such a case the accounting equation of assets equal liabilities plus equity would still hold true but the liabilities would exceed the assets since the equity section is negative. Here again the computer continues to automatically provide funds but in a situation where

funds would not be available in the real world. Thus, a firm which has met the conditions for insolvency in bankruptcy may in fact be permitted to continue operations whereas in the real world such a firm would typically file, either voluntarily or involuntarily, for Chapter 7 bankruptcy and liquidate.

One could argue that the simulation does not have to force firms into bankruptcy automatically since the instructor should be deciding how to handle these cases of poor performance. This argument is certainly true: it is the responsibility of the instructor to decide whether to permit or force firms to file for Chapter 7 or Chapter 11 bankruptcy. Unfortunately the bankruptcy issue does not appear to be addressed in the simulation literature.

The purpose of this study was to investigate whether there are ways to utilize a widely accepted and used real-world bankruptcy indicator, the Altman Z (Altman. 1968) in a simulation environment. It would seem that such an indicator might be useful in three different ways. First, it could be used to predict whether firms are likely to encounter difficulty so the instructor can intervene. Second it could be used to assess performance in order to decide whether a firm should reorganize or liquidate. Third it could be used to evaluate a firm's performance for grading purposes.

THE ALTMAN Z

The Altman Z. a technique for predicting bankruptcy was introduced in 1968 (Altman. 1968). Using the period 1946 to 1965. Altman (1968) studied 33 manufacturing companies, which had filed for bankruptcy. As a control' he also studied 33 non-bankruptcy manufacturing firms selected at random. He used financial ratios to predict which firms would go bankrupt. He then applied multiple discriminant analysis to the sample of 66 corporations which generated the following index:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

where X_1 = working capital divided by total assets
X_2 = retained earnings divided by total assets
X_3 = earnings before interest and taxes divided by total assets
X_4 = market value of equity divided by book value of total debt
X_5 = sales divided by total assets

Using this index Altman found that 94 percent of the firms that went bankrupt over this time period had Z scores of less than 2.675 one year prior to bankruptcy while only 6 percent had scores above 2.675. Conversely, only 3 percent of the firms which did not go bankrupt had Z scores below 2.675 and 97 percent had scores above 2.675 (Petty, Keown, Scott, and Martin. 1993. p. 624). Thus, the index seemed to discriminate between firms, which were likely or not likely to go bankrupt. Heimann and Hawkins (1976:3) state in their discussion of the Altman study: "It is determined that firms with a Z score greater than 2.99 clearly fall into the non-bankrupt group while those with Z scores less than 1 .81 are all 'bankrupt.' Those falling into the area between 1 81 and 2.99, the 'grey area.' require further in depth analysis to determine their solvency status. More information on the derivation of the formula, its implications, and other research can be found in Altman (1971) and Argenti (1976).

n subsequent research Altman. Haldeman and Narayanan (1977) developed a seven variable model, called ZETA.™ which they indicate improved upon the original five variable model. This study used data for the period 1969 through 1975 for 53 bankrupt firms and a matched sample of 58 non-bankrupt firms. The firms studied included manufacturing and retailing firms. Unfortunately, Altman, Haldeman and Narayanan (1977) do not provide the coefficients for the seven variables so the newer model has not been used and researched by others. As a consequence the original five variable model is the one most cited and the one which will be used in the current study.

The use of the original' five variable model does not seem to be problematic in the current study for a number of reasons. First, the original study used only manufacturing firms while the later study included non-manufacturing firms as well. While this addition is important for the study of firms in general it is not important in the context of the current study since the simulated firm is a manufacturing firm. Second, the results of the original' study are quite good for predicting bankruptcy one year in advance (95%) and fairly good for two years in advance (76%). In fact, the original model was slightly more accurate than the new model for non-bankruptcy classification in the two years when direct comparison between the two models was possible (Altman. et al. 1977). Since simulated environments tend to run for three to five years, in most instances being able to make predictions only for the next year is not problematic. Also, if the predictions are being made so that the instructor can intervene by consulting with the firm, the one year in advance prediction is adequate. Finally, as noted by Altman et at (1977:40) in their comparison of the original and new models, the original model appears to be quite good: "Once again the ZETA model dominates in every year, but notice that the new 7-

variable model is, in some years, only slightly more accurate than

the "old %-variable model

RESEARCH METHODOLOGY

The data for this study was gathered from two classes in a senior level business policy and formulation course in which a simulation was used. In the first class there were 10 firms and 12 quarters (3 years) of operations were simulated: while in second class there were eight firms and 16 quarters (4 years) were simulated. The simulation used was Micromatic A Management Simulation (Scott and Strickland. 1992). This simulation is a widely used moderately complex general management simulation. The students take over a firm which has been in existence for two years so the first set ol decisions is for quarter 9 (i.e.. year 3. quarter 1).

The data necessary to calculate the Altman Z were recorded from each firm's output. One advantage of the Altman Z is that it requires a fairly small amount of data. There are only ten variables (current assets, total assets. current liabilities, total debt. accumulated retained earnings, stock price. sates revenue, earnings before interest and taxes. shares of stock outstanding. and working capital) which are needed per firm per time period and one of these (working capital) can be calculated from two of the others (current assets minus current liabilities). While the Altman Z is based upon annual data, the current study also looked at quarterly data. This approach was used because the authors were interested in looking at using the analysis not only as a way to evaluate performance. but as a means to heap the instructor decide whether or not to intervene, and early intervention seemed preferable to later. For the quarterly calculations we 'annualized" the two income statement items (sales and earnings before interest and taxes) by multiplying by four to put them on an appropriate basis for the Altman Z formula.

Annual data was generated by recording: (1) the year end value for balance sheet items (i.e.. current assets. total assets, current liabilities, working capital. total debt, and accumulated retained earnings): (2) the sum of the quarterly results for a given year for the income statement items (i.e.. sales revenue, and earnings before interest and taxes): and. (3) the number of shares outstanding at the end of the year and the year end stock price.

The quarterly and annual Altman Z scores were calculated. Next, the frequency and percent of times that firms fell into the bankruptcy area (Z<1 .81) the grey area (Z between 1.81 and 2.99) and the safe area (Z>299) were calculated for the quarterly and annual data. Finally Bayesian transition probability matrices were developed for both the quarterly data and annual data to look at the likelihood of a firm moving from one condition to another.

RESULTS

The frequency and percentage data for the annual Altman **Z** scores by firm are presented in Table 1. There were 62 possible data points (10 firms for three years plus eight firms for four years) included in the analysis. As can be seen from Table 1. 27.4% of the Altman Z scores were <1.81. 274% were between 1.81 arid 299. and 45.2% were >299. Thus, the greatest number of situations were in the safe area. This result held true for each of the classes as well. It is also apparent from Table 1 that one of the firms would have been classified as bankrupt in each of the simulated years and four would have always have been in the safe area. The range of scores across all firms was quite large from a low of .50 to a high of 33.46. It is worth noting that when the teams took over operation the firm had Z scores of 2.26 and 3.24 for the previous two years, which indicated it was in relatively good financial condition.

The frequency and percentage data for the quarterly Altman Z scores by firm are presented in Table 2. There were 248 possible data points (10 firms for 12 quarters

plus 8 firms for 16 quarters). As can be seen from Table 2. 290% of the Altman **Z** scores were <1.81. 21.0% were between 1.81 and 299 and 50% were >2.99 which indicates the greatest number of the situations were in the safe area Again, some firms were always in the safe area, however, no firm was always in the bankruptcy area The range of scores was quite large from a low of -68 to a high of 348.27. The quarterly scores prior to the students taking over operation of the firm ranged from 1.22 in quarter 3 to 3.31 in quarter 8 (i.e.. the quarter prior to when the students began game play). The remaining quarters were all over 2.00 but below 2.99 so they were in the gray area. Since quarter 8 was >2.99 the firm was considered to be in good financial condition when the students took over operations.

The annual and quarterly Bayesian transition probabilities are presented in Tables 3 and 4, respectively. The transition probabilities show that the firms did move from one condition to

TABLE 1
ANNUAL Z SCORE RESULTS BY FIRM

	Number of Years Altman Z Criterion Between			Percent of Years Altman Z Criterion Between		
		1.81 &			1.81 &	
Firms	<1.81	2.99	>2.99	<1.81	2.99	>2.99
1	3	0	0	100.0%	0.0%	0.0%
2	0	2	1	0.0%	66.7%	33.3%
3	1	0	2	33.3%	0.0%	66.7%
4	0	0	3	0.0%	0.0%	100.0%
5	2	1	0	66.7%	33.3%	0.0%
6	2	1	0	66.7%	33.3%	0.0%
7	1	2	0	33.3%	66.7%	0.0%
8	0	1	2	0.0%	33.3%	66.7%
9	1	0	2	33.3%	0.0%	66.7%
10	0	2	1	0.0%	66.7%	33.3%
1	0	3	1	0.0%	75.0%	25.0%
2	1	3	0	25.0%	75.0%	0.0%
3	0	0	4	0.0%	0.0%	100.0%
4	3	1	0	75.0%	25.0%	0.0%
5	0	0	4	0.0%	0.0%	100.0%
6	0	0	4	0.0%	0.0%	100.0%
7	3	0	1	75.0%	0.0%	25.0%
8	0	1	3	0.0%	25.0%	75.0%
Class 1	10	9	11	33.3%	30.0%	36.7%
Class 2	7	8	17	21.9%	25.0%	53.1%
Total	17	17	28	27.4%	27.4%	45.2%

TABLE 2
QUARTERLY Z SCORE RESULTS BY FIRM

	Number of Quarters Altman Z Criterion Between			Percent of Quarters Altman Z Criterion Between		
		1.81 &			1.81 &	
Firms	<1.81	2.99	>2.99	<1.81	2.99	>2.99
1	11	1	0	91.7%	8.3%	0.0%
2	3	5	4	25.0%	41.7%	33.3%
3	2	1	9	16.7%	8.3%	75.0%
4	0	2	10	0.0%	16.7%	83.3%
5	6	6	0	50.0%	50.0%	0.0%
6	5	7	0	41.7%	58.3%	0.0%
7	5	4	3	41.7%	33.3%	25.0%
8	1	1	10	8.3%	8.3%	83.3%
9	4	0	8	33.3%	0.0%	66.7%
10	2	6	4	16.7%	50.0%	33.3%
1	5	5	6	31.3%	31.3%	37.5%
2	8	4	4	50.0%	25.0%	25.0%
3	0	0	16	0.0%	0.0%	100.0%
4	12	2	2	75.0%	12.5%	12.5%
5	0	2	14	0.0%	12.5%	87.5%
6	0	0	16	0.0%	0.0%	100.0%
7	7	3	6	43.8%	18.8%	37.5%
8	1	3	12	6.3%	18.8%	75.0%
Class 1	39	33	48	32.5%	27.5%	40.0%
Class 2	33	19	76	25.8%	14.8%	59.4%
Total	72	52	124	29.0%	21.0%	50.0%

another (e.g.. <1.81 to between 1 81 and 2.99). It is evident, however that some of the moves were unlikely (e.g.. from <1.81 to >2.99) and that the most likely condition for a firm was its

previous condition (I.e.. the highest probabilities are all on the diagonal from upper left to lower right).

DISCUSSION

The results of this study indicate that the Altman Z does have potential use in simulation environments for each of the three

TABLE 3
ANNUAL TRANSITION PROBABILITY MATRIX

		To	
		Between	
	<1.81	1.81 & 2.99	>2.99
From			
<1.81	63 64%	36.36%	0.00%
Between	25.00%	50.00%	25.00%
>2.99	17.95%	17.95%	64.10%

		To	
		Between	
	<1.81	1.81 & 2.99	>2.99
From			
<1.81	66.18%	27.94%	5.88%
Between	31.25%	35.42%	33.33%
>2.99	9.85%	11.36%	78.79%

purposes cited earlier. First, it could be used to predict whether firms have encountered or are likely to encounter difficulty so the instructor can intervene in a timely fashion. The quarterly data in particular lets one look at firms which may be experiencing difficulty. When there are two consecutive quarters in which the Z scores indicate that firm vs at or near bankruptcy. it would appear that the instructor should consult with the firm. Even a single quarter with an extremely low score may warrant discussion, The discussion could also focus on what the Altman Z might tell management about turning the company around. While Altman did not develop the model as a turn around tool it has, in fact, been used in this fashion by Mr. James La Fleur, CEO, at GTI. He notes that by changing assets you change four of the five ratios, which are part of the formula. Thus, by focusing on assets a firm could begin to turn things around by setting a target Z score and looking at what changes would have to occur to achieve it, The instructor could provide the team with this insight and let them work it through.

Second, the Altman Z could be used to assess performance in order to decide whether a firm should reorganize or liquidate. The Altman Z gives a solid basis to the instructor to suggest that a firm follow a bankruptcy strategy. The instructor will still have to decide

how such a strategy can be implemented. If the decision is to reorganize the instructor could forgive some of the debt with the understanding that once the firm returns to solvency status it will be expected to repay these creditors. If the decision is to liquidate the firm the instructor has a more difficult situation with which to deal: Will the simulation permit a firm to be eliminated and if so how does this effect the other firms? What happens to the students of the liquidated firm? Do they fail' the course? Are they assigned to another firm? Do they take over some other firm?

Finally, the Altman Z could be used to evaluate a firm's performance for grading purposes. Almost from the inception of the first practical business simulation over 35 years ago there has been research concerning how participants should be evaluated (Vance and Gray. 1967). Some of the research has focused on the use of single or multiple performance measures or techniques to use in performance evaluation (Anderson and Lawton, 1988: Biggs, 1978: Hand and Sims. 1975; House and Napier. 1988: Sackson, 1992: Sims and Hand. 1975: Wheatley, Amin, at specific variables, which might be used such as profits (Teach. 1990) or forecasting accuracy (Teach. 1993a, 1993b; Wolfe. 1993a. 1993b). The suggestion that the Altman Z might be used as a criterion for evaluating performance adds yet another specific quantitative variable to the list. One of the advantages of the Altman Z as an evaluation criterion is that it uses not only data from the income statement and balance sheets but stock price as well. Thus while it is a single measure, it uses a great amount of the information about the firm. Another possible way the Altman Z could be used to evaluate performance would be to build upon the idea of having firms begin from different starting points (Pray and Gold. 1991). If we knew at the outset the condition of the firm with respect to potential for bankruptcy we might be able to develop an index which permits adjustment for such a difference.

It appears from the current study that instructors can use the Altman Z in simulated environments to achieve a variety of purposes. Clearly more research is warranted to document its applicability to simulations in general as well as specific simulations.

Another use and therefore potential avenue for research was suggested by an anonymous reviewer who argued that the scope of the paper should be broadened to include design issues. This reviewer indicated that game developers should design "a system which forces the firm to take measures to avoid bankruptcy (if that is possible)." Further, 'As a marketer. I am not much interested in having students deal with bankruptcy details. But the lack of realism now present does bother me a bit. A design that somehow prevents the possibility

of bankruptcy of a firm would be more acceptable than a design that allows " dead firms to survive.'

The authors see two major ways in which simulations could be designed to prevent bankruptcy. First, the firms could be given extensive resources and parameters could be set so that the Z score would not go below 1.81. This approach, however, merely substitutes one type of unrealistic situation for another. The fact vs that firms do not have unlimited resources and, therefore must be prepared to deal with the possibility of constrained decisions and potentially poor performance. Second, the simulation could be designed to automatically forgive debt. Here again an unrealistic situation is created. It is our view that administrative responses to bankruptcy are superior to these types of design responses.

It would be particularly undesirable to design out the possibility of bankruptcy in general management simulations. Such simulations are designed to have students take a top management point of view and deal with all functional areas. The potential for bankruptcy is a real one for firms and, therefore, should be possible in simulated environments. We do agree that firms should not be permitted to continue in a bankruptcy status. Rather, as indicated previously, the instructor needs to decide how to deal with bankruptcy.

It may be that there is more justification to design out the possibility of bankruptcy in functional simulations. These types of simulations are designed to have the student focus on a specific functional area and therefore, except in finance simulations, the focus is not on financial issues, Even here, however, the authors are concerned about using either of the design methods suggested above to eliminate bankruptcy. Even in a functional simulation should game designers and administrators imply to students that they have unlimited resources?

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