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Auditor Versus Model: Information Choice and Information Processing

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ABSTRACT: This paper examines the comparative effect of information choice and information processing on the judgment performance of auditors over two different levels of environmental predictability. The task was the prediction of corporate failure. The study found that information choice, as evidenced through suboptimal selection of ratios, was a limiting factor in performance. However, although subjects were able to utilize all the information from the ratios they selected, they were unable to improve performance when supplied with the superior combination of ratios determined by the environmental model. Thus, information processing also became a limiting factor in performance when subjects were unable to choose their own ratios.

More than a decade has passed since Einhorn [1976] outlined some neglected issues in judgment research. Two of these issues which have received only limited attention in the accounting literature are the focus of this paper. First, Einhorn suggested that researchers in human information processing begin to incorporate information search and choice in their experimental designs. Second, he emphasized the importance of task effects on judgment/decision making.

The importance of examining information choice has since been supported in both the psychology and accounting literature (e.g., Abdel-khalik and El-Sheshai [1980], Einhorn and Hogarth [1981], Libby [1981], Trope and Bassok [1982], Kida [1984], and Lewis et al. [1988]). Einhorn and Hogarth [1981] emphasize that the process of information search and acquisition should be considered since evaluation and search strategies are interdependent.

One study in the accounting literature that allowed decision makers to choose the information cues they used in making their judgments was Abdel-khalik and El-Sheshai [1980]. The main purpose of their paper was to evaluate the relative contribution of the acts of information choice and information processing in decisions made by loan officers in predicting company default. They concluded that the subjects' choice of information, rather than their processing of

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the chosen cues, was the limiting factor in predicting the environmental event.

While the results of the Abdel-khalik and El-Sheshai [1980] study support the importance of information choice over weighting [Dawes and Corrigan, 1974], they appear to be inconsistent with some psychology and accounting research which suggests that humans are better at choosing rather than processing information. Dawes [1979, p. 573], in a discussion of the use of linear models, states:

> The linear model cannot replace the expert in deciding such things as "what to look for," but it is precisely this knowl-

The purpose of the present study is to further examine the comparative effect of information choice and information processing on the performance of users of accounting information over different levels of task complexity. The task is the prediction of corporate failure by auditors and is similar to the one used by Kida [1980]. This study is undertaken in Australia where there is a legal requirement for the Directors' Statement to include a comment that there are reasonable grounds to believe that the company will be able to pay its debts as and when they fall due. As this statement is covered by the audit report, the auditor

TABLE 1

COMPARISON OF THE RESULTS OF THE STUDIES BY ABDEL-KHALIK AND EL-SHESHAI [1980] AND LEWIS ET AL. [1988][1]

Strategy	*Denoted*	*Evaluating the Predictive Ability of the Environmental Event*	*Abdel-khalik and El-Sheshai Study Percent of Correct Prediction*	*Lewis et al. Study Percent of Correct Prediction*
S1	HP/HS	The judge's validity (achievement index) using human-selected information.	0.625 (average)	0.45 (average)
S2	MP_a/HS	The validity of the "model of man" using human-selected information.	0.625[2] (average)	0.42 (average)
S3	MP_a/HS	Environmental mathematical model using information selected by humans.	0.675 (average)	0.45 (average)
S4	HP/MS	The judge's validity using model-selected information.	not studied	0.44 (average)
S5	MP_a/MS	The validity of the "model of man" using model-selected information.	not studied	0.44 (average)
S6	MP_a/MS	Environmental mathematical model using model-selected information.	0.906	0.60[3]

[1] Note that the two-way classification scheme of Abdel-khalik and El-Sheshai [1980] gives a probability of initial assignment to groups of 50 percent compared with 33.3 percent for the three-way classification of Lewis et al.

[2] Strategy S2 uses the linear model estimated from human responses and the information cues that they used to predict the environmental event. The model of man correctly predicted 84 percent of the responses of the judges. The 62.5 percent correct classification shown in the table is the percentage of correct prediction of the environmental event using the "model of man."

[3] The percentage of correct prediction fell to 41 percent on the validation model.

percent for strategy S1 (HP/HS), Abdelkhalik and El-Sheshai [1980] concluded that information choice was the major reason for the inferior prediction achievement. If this conclusion fully explains the inferior prediction we would expect strategy S4 or HP/MS (MS denotes model-selected information), which was not examined, to significantly outperform S1 and be close in performance to S6. Alternatively, if S4 does not outperform S1 it would suggest that either (1) the best linear model using model-selected variables was an overfit so that S6 was artificially high, or (2) humans have difficulty in combining information which they do not choose, leading to a lower accuracy for human judgments using model-selected data. For example, they may not have chosen a variable because they did not fully understand it or because they normally do not use that variable.

Lewis et al. [1988] extended the Abdelkhalik and El-Sheshai [1980] study by investigating the effects of information choice and information processing on the quality of municipal financial analysts' predictions concerning changes in the general obligation bond ratings of cities. Their results are also shown in Table 1. The authors included an S4 group but found performance of this group (0.44) to be similar to S1 (0.45) and inferior to S6 (0.60). To consider the possibility that the superiority of S6 was due to overfitting, they developed a validation sample. The performance of their statistical model (S6) dropped from .60 to only .41 on the validation model and the authors suggest there was some overfitting of their best statistical model due to the small number of cities in the original sample. They conclude that after adjusting for the situation specific advantage of statistical models, their results showed fairly even performance between models and man in selecting and processing data to predict bond rating changes.

On the basis of Lewis et al. [1988] it can be concluded that subjects given model-selected data (S4) do not perform any better than those given self-selected data (S1) and that the lower performance of S4 compared to the statistical model (S6) can in part be attributed to some overfitting of the statistical model. However, these conclusions are subject to a number of validity threats. First, the reason for S4 subjects not outperforming S1 subjects could be related to different motivation levels, with S4 subjects being less motivated than S1 subjects. In the first part of the experiment all subjects were asked to choose the five pieces of information that they believed would be most useful in predicting the bond rating changes. However, in the second part of the experiment, only S1 subjects received the ratios they chose. S4 subjects were given the model-selected ratios and not those they selected, which may have adversely affected their motivation and thus reduced the performance of S4. Some support for the differences in motivation is that subjects receiving self-selected data responded more often (54 percent) than did those receiving the model-selected data (32 percent). Second, it was necessary for the authors to use a surrogate validation sample, as their original sample exhausted the list of cities changing from A rating during the time period for which they had data. However, it appears that the task in the validation sample could have been quite different. That is, the validation sample had to distinguish between bond ratings of A1, A, or BAA, while the original sample was based on changes in ratings. If the changes were greater than the fine distinction between A and A1, it would be easier to classify the original sample,

resulting in a lower accuracy rate for the validation sample.

The present study extends the research on information choice considered in Abdel-khalik and El-Sheshai [1980] and Lewis et al. [1988] in the following ways. First, we examine the full matrix of six possible combinations suggested by Abdel-khalik and El-Sheshai, on a similar prediction of failure task, in order to consider the validity of their conclusion that it is subjects' choice of information rather than their processing of the cues that limits performance. Second, we extend Lewis et al. by (1) dividing our original sample into two groups in order to have a validation sample rather than a "surrogate validation sample" to minimize the problem of possible overfitting; (2) attempting to avoid decreasing the motivation of S4 subjects by not asking them to select their preferred ratios before they performed the task with the ratios selected by the model; and (3) using a controlled administration of the experiment. Third, the effects of information choice and information processing are examined across different levels of environmental predictability, which is one dimension of task complexity. While task complexity is often varied in the psychology literature by manipulating the number of cues, Wood [1986] suggests that the strength of the relation between information cues and the objective criterion is an important aspect of complexity.

Research Method

Independent Variables

The task was the prediction of business failure using a set of financial ratios. The main task characteristic manipulated was whether subjects chose their own ratios or were given the ratios selected by an environmental model. The other characteristic manipulated was environmental predictability, which was operationalized by manipulating the number of years in advance of the event the prediction was made.[1]

Cases Used

The population of failed/non-failed firms for this study was comprised of the 103 corporations that were used in Izan [1984]. From this population, firms that had not been operating for at least three years and those in "extreme" industries were eliminated. "Extreme" industries were identified by reviewing industry average ratios and were eliminated in order to reduce the effect of industry specific information. The 63 remaining firms (30 failed, 33 non-failed) belonged to industry categories that could be broadly classed as "retail and manufacture." Of these, the 30 failed and 30 randomly selected non-failed firms were included in the study. These firms were randomly assigned to two samples of 15 failed, 15 non-failed firms. The first sample was used for developing the environmental model (model development sample), with the second sample being used to test the model's validity (validation sample). The subjects made their failed/non-failed predictions on this validation sample. Thus, Lewis et al. [1988] suggestion of comparing subjects' prediction achievement rates to the statistical models' validation sample hit rate was followed.

[1] Izan [1984], in her analysis of failed firms in Australia, found that failure one year from the event was more predictable than two years from the event. The discriminant model correctly predicted failure/non-failure in 91.9 percent of situations using ratios one year from the event and 82.0 percent of situations using ratios two years from the event.

Development of the Environmental Model

Ten of the ratios from the Izan [1984] data base were used in the development of the model:

1. Earnings before Interest and Tax to Total Assets (EBTA)
2. Earnings after Interest and Tax to Total Assets (EATA)
3. Cash Flow before Tax to Financial Debt (CFFD)
4. Times Interest Earned (TIA)
5. Current Ratio (CR)
6. Quick Asset Ratio (QAR)
7. Market Value of Equity to Total Liabilities (MVTL)
8. Book Value of Equity to Market Value of Equity (BVMV)
9. Working Capital to Total Assets (WCTA)
10. Retained Earnings to Total Assets (RETA)

The other two ratios calculated by Izan [1984] were omitted because both the numerator and denominator could be negative for some firms, which would result in a positive ratio for these firms and a possible misleading indicator to subjects for a failed firm.

Discriminant analysis was used to develop separate environmental models for both one and two years prior to failure. The stepwise inclusion technique of minimizing Wilks' Lambda was used, and the discriminant model was allowed to select four discriminating variables.[2] The discriminant function ($\chi^2(4)=23.15$, $p<.0001$) for the model development sample one year prior to failure selected the following ratios: EATA, TIA, CR, and BVMV. The overall classification power of this model was 93.3 percent. The breakdown between failed and non-failed organizations is contained in Table 2 under the subheading Year One —Model Development Sample.

The correlation matrix for the model development sample is provided in Table 3 (panel A). There are high correlations between some of the ratios, especially EBTA and EATA (0.841), CR and WCTA (0.812), and CR and QAR (0.732). As the stepwise technique is not guaranteed to provide the "best" model, especially when there are high correlations between the variables, all possible combinations of four ratios were examined (210 combinations). No combination outperformed the model chosen although 24 of these combinations had equal performance. The predictive accuracy of these combinations ranged from 73.33 percent to 93.33 percent which indicates that there was scope for choice of ratios to have a significant effect. This was also supported by the substantial variation in predictive accuracy of the individual ratios as shown in Table 3 (panel A).

The discriminant function obtained from the model development sample was then tested on the validation sample for year one. The predictive power for the validation sample in year one using the weightings obtained from the model development sample was 93.3 percent, indicating no shrinkage. The breakdown between failed and non-failed organizations is included in Table 2 under the subheading Year One—Validation Sample.[3]

The correlation matrix for the valida-

[2] Limiting cue choice to between two and four cues has been found to give optimal model performance, with additional variables resulting in statistically overfitted models and a decrease in cross-validation accuracy [Chalos and Pickard, 1985]. Performance of subjects has also been found to decrease if too many cues are required to be processed [Ogilvie and Schmitt, 1979]. In this task optimal environmental model performance was found to occur with the processing of four cues.

[3] The discriminant function derived directly from the year one validation sample correctly predicted 96.7 percent of the cases.

TABLE 2
OVERALL CLASSIFICATION POWER OF DISCRIMINANT FUNCTIONS

Model Development Sample ($n=30$)			*Validation Sample* ($n=30$)		
	Predicted Group Membership			*Predicted Group Membership*	
Actual Group Membership	*Failed*	*Non-Failed*	*Actual Group Membership*	*Failed*	*Non-Failed*
YEAR ONE					
Failed	13 (86.7%)	2 (13.3%)	Failed	14 (93.3%)	1 (6.7%)
Non-Failed	0 (0%)	15 (100%)	Non-Failed	1 (6.7%)	14 (93.3%)
Overall classification power: 93.3%			Overall classification power: 93.3%		
YEAR TWO					
Failed	11 (73.3%)	4 (26.7%)	Failed	10 (66.6%)	5 (33.3%)
Non-Failed	1 (6.7%)	14 (93.3%)	Non-Failed	1 (6.7%)	14 (93.3%)
Overall classification power: 83.3%			Overall classification power: 80%		

TABLE 3
POOLED WITHIN-GROUPS CORRELATION MATRICES
($n = 30$)

Panel A. Model Development Sample—Year One:

	EBTA[1]	*EATA*	*CFFD*	*TIA*	*CR*	*QAR*	*MVTL*	*BVMV*	*WCTA*	*RETA*
EBTA	1.000									
EATA	0.841	1.000								
CFFD	0.252	0.174	1.000							
TIA	0.641	0.449	0.311	1.000						
CR	0.229	0.148	−0.190	0.145	1.000					
QAR	0.186	0.036	0.072	0.128	0.732	1.000				
MVTL	0.243	0.182	0.429	0.550	−0.007	−0.174	1.000			
BVMV	0.514	0.506	−0.049	0.104	0.410	0.364	−0.189	1.000		
WCTA	0.477	0.343	−0.106	0.243	0.812	0.475	−0.017	0.509	1.000	
RETA	0.656	0.714	0.047	0.319	0.305	0.117	0.082	0.294	0.615	1.000
Individual Predictive Ability Percent	76.7	66.7	56.7	86.7	73.3	70.0	70.0	56.7	80.0	76.7

TABLE 3—*Continued*

Panel B. Validation Sample—Year One:

	EBTA	*EATA*	*CFFD*	*TIA*	*CR*	*QAR*	*MVTL*	*BVMV*	*WCTA*	*RETA*
EBTA	1.000									
EATA	0.707	1.000								
CFFD	0.180	0.297	1.000							
TIA	0.612	0.455	0.473	1.000						
CR	0.036	0.018	0.073	0.069	1.000					
QAR	0.181	0.146	0.249	0.124	0.700	1.000				
MVTL	0.161	0.392	0.756	0.372	−0.232	0.093	1.000			
BVMV	0.028	−0.191	−0.051	0.106	0.162	0.199	−0.077	1.000		
WCTA	−0.007	0.035	−0.120	−0.054	0.891	0.642	−0.256	0.180	1.000	
RETA	0.397	0.308	0.118	0.406	0.507	0.301	−0.120	0.200	0.399	1.000
Individual Predictive Ability Percent	86.7	90.0	70.0	90.0	73.3	66.7	70.0	76.7	66.7	70.0

[1] EBTA = Earnings before Interest and Tax to Total Assets
EATA = Earnings after Interest and Tax to Total Assets
CFFD = Cash Flow before Tax to Financial Debt
TIA = Times Interest Earned
CR = Current Ratio
QAR = Quick Asset Ratio
MVTL = Market Value of Equity to Total Liabilities
BVMV = Book Value of Equity to Market Value of Equity
WCTA = Working Capital to Total Assets
RETA = Retained Earnings to Total Assets

tion sample is also included in Table 3 (panel B). High correlation was again found between the combinations of EBTA and EATA, CR and WCTA, and CR and QAR as well as between CFFD and MVTL. Also included in Table 3 (panel B) are the predictive abilities of the individual ratios. As with the model development sample there is again considerable variation. The main difference is that the predictive power of the earnings ratios are higher for the validation sample than for the model development sample. In order to maintain similarity between all task characteristics with the exception of predictive ability, the ratios that had been selected in year one by the environmental model were imposed upon the year two model development sample. The overall percentage of cases correctly classified on the year two model development sample was 83.3 percent. The breakdown between failed and non-failed organizations is included in Table 2 under the subheading Year Two—Model Development Sample. On applying the discriminant function derived from the year two model development sample (maintaining year one ratios) to the validation sample, the percentage of cases correctly classified was 80 percent. The breakdown between failed and non-failed organizations is included in Table 2 under the subheading Year Two—Validation Sample.[4]

Subjects, Procedure, and Task

The subjects in this study were 84 senior auditors drawn from six Big Eight accounting firms. The firms provided 14, 9, 20, 17, 8, and 16 subjects, respectively. Each subject had between three and six years experience.

Subjects were randomly assigned to one of four treatments (21 subjects per treatment). Subjects in treatments one and two (HS subjects) were asked to identify those four ratios out of the ten provided that they would like to be supplied with in order to distinguish between failed and non-failed firms. Those subjects in treatment one were provided with the ratios one year prior to possible failure and were asked "will this firm go bankrupt within one year?" on a Yes/No basis, and "what is the probability that your answer is correct?" on a six-point scale ranging from 0.5 to 1.0. The only change for treatment two subjects was that they were given the ratios they chose for two years prior to possible failure and were asked "will this firm go bankrupt within two years?" Subjects in treatments three and four (MS subjects) were provided with the four ratios selected by the model (EATA, TIA, CR, and BVMV). Treatment three subjects were given the ratios one year prior to possible failure, while treatment four subjects were given ratios two years prior to possible failure. For all treatments subjects were given written definitions of all relevant ratios that were not fully explained by their title. All subjects received the 30 cases comprising the validation sample. Subjects were told that the study used actual firm data and that the sample of 30 firms had been randomly selected from a population of an equal proportion of bankrupt/non-bankrupt firms. They were also informed that all firms were in the retail or manufacturing industries and had been in existence for at least three years. The experiment was administered in a controlled setting at the offices of each of the six accounting firms. Subjects in treatments one and two completed the experiment in a different room than subjects in treatments

[4] The discriminant function derived directly from the year two validation sample correctly predicted 90 percent of the cases.

TABLE 4
RATIOS SELECTED BY HS SUBJECTS (TREATMENTS ONE AND TWO)
($n=21$ FOR EACH YEAR)

	Number of Subjects Selecting Each Ratio	
	Year 1	*Year 2*
Earnings before Interest and Tax to Total Assets (EBTA)	3	7
Earnings after Interest and Tax to Total Assets (EATA)*	5	7
Cash Flow before tax to Financial Debt (CFFD)	15	13
Times Interest Earned (TIA)*	9	11
Current Ratio (CR)*	14	14
Quick Asset Ratio (QAR)	17	15
Market Value of Equity to Total Liabilities (MVTL)	10	7
Book Value of Equity to Market Value of Equity (BVMV)*	3	2
Working Capital to Total Assets (WCTA)	6	4
Retained Earnings to Total Assets (RETA)	2	4

* Ratios selected by model.

three and four. The reason for this was so the latter did not know that the former had the opportunity to select their own ratios. One of the researchers was in each of the two rooms. In addition, a research assistant was available to help with the HS subjects (treatments one and two) as it was necessary to provide them the ratios on an individual basis after each participant had selected their four ratios. To increase the efficiency of this process, envelopes containing each of the ten ratios were prepared in advance and the ratios selected could quickly be attached to the research instrument for each individual. Individuals were instructed to indicate whether they had been supplied with the requested ratios.

RESULTS

Ratio Selection

The ratios selected by the subjects in years one and two are set out in Table 4. This table shows relatively high consistency in the selection pattern between the two years. On both occasions selection was dominated by the ratios CFFD, CR, and QAR, revealing that the subjects preferred information on cash flow and short-term financial position for making bankruptcy predictions. There was limited overlap between the ratios preferred by the subjects and those chosen by the model, with only CR (both years) and TIA (year two) being in the top four ratios chosen by both the subjects and the model.

The Effect of Complexity

The success rates using ratios one and two years prior to bankruptcy are contained in Table 5. It is not possible to do one ANOVA including environmental predictability (year), information choice, and information processing as the main effects because S6 consists of a single observation. Consequently, the following two separate analyses are made initially to test whether environmental predictability interacts with either choice or processing. Both a 2×2 ANOVA (information choice $\times$ environmental predict-

TABLE 5
SUCCESS RATES USING RATIOS ONE AND TWO YEARS PRIOR TO BANKRUPTCY

	Information Selection	
	By Subject (HS)	*By Model (MS)*
YEAR ONE		
Information Processing		
By Subject (HP)	81.1% (S1)	82.5% (S4)
By Model of Man (MP_a)	78.4% (S2)	83.0% (S5)
By Model (MP_e)	81.4% (S3)	93.3% (S6)
YEAR TWO		
Information Processing		
By Subject (HP)	74.0% (S1)	75.1% (S4)
By Model of Man (MP_a)	72.7% (S2)	74.8% (S5)
By Model (MP_e)	77.8% (S3)	80.0% (S6)

ability) for strategies S1 and S4 and a 2×2 ANOVA (information processing × environmental predictability) for strategies S1 and S3 were examined. Both sets of analyses show an environmental predictability effect (S1 and S4; $F(1) = 16.94$, $p < .01$; S1 and S3: $F(1) = 8.59$, $p < .01$) indicating as expected that subjects had lower performance using year two ratios than year one ratios. In addition the two sets of analyses show that this variable did not interact with either information choice ($F(1) = 0.03$, $p = .86$) or cue processing ($F(1) = 1.01$, $p = .32$). As the measure of task complexity used does not interact with information choice or processing, the remainder of the analysis aggregates across complexity where appropriate by combining the data from years one and two.

The Effect of Information Choice/ Information Processing

To examine the information choice/ information processing issue the following specific comparisons are made: S1 to S4, S3 to S6, S1 to S3, and S4 to S6.

The first comparison of S1 to S4 compares the performance of those subjects who select and process the information (HS) to those who are given model-selected ratios (MS) to process. That is, for both S1 and S4 the processing is done by the subjects, the difference being that for S1 the information selection is made by the subject while for S4 the information selection is done by the model. Given Abdel-khalik and El-Sheshai's [1980] conclusion that information choice was the major reason for the inferior predictive ability, it would be expected that S4 would outperform S1. In the 2×2 ANOVA (information choice × environmental predictability) outlined above, the main effect for information choice is not significant ($F(1) = 0.38$, $p = .54$) indicating that there was no significant difference between subjects' ability to predict when they selected the ratios (S1) compared with their ability to predict when they were given model-selected ratios (S4). This suggests that (1) there was no increased information in the model-selected ratios, or (2) although

there was additional information, subjects could not fully utilize the information content of the ratios selected by the model.

To consider the first of the above explanations, the next comparison was of S3 and S6. For both S3 and S6 the processing is done by the model (MP_e), the difference being that for S3 the information selection is done by the subjects whereas for S6 the selection is done by the model. As stated above, S6 is a single observation and no ANOVA is possible. Instead, S6 was subtracted from each value of S3 (across both years) and the resulting values were significantly different from zero ($t = -5.23$, $p < .001$). This shows that S6 outperformed S3 and there was additional information content in the model-selected ratios. This eliminates alternative (1) in the paragraph above as an explanation for S4 not outperforming S1.

To examine the second potential explanation for the failure of S4 to outperform S1 (namely that subjects could not fully utilize the information in the ratios selected by the model), S4 was compared to S6. For both S4 and S6 the ratio selection is done by the model (MS), the difference being that for S4 the information is processed by the subjects (HP) whereas for S6 the information is processed by the model (MP_e). To test this comparison, S6 was subtracted from each value of S4 and the resulting values were significantly different from zero ($t = -6.36$, $p < .001$). This shows that S6 outperformed S4 and that S4 subjects were unable to use all the information in the model-selected ratios.

The final comparison considers whether subjects are also unable to use all the information in the ratios they selected themselves. To consider this question S1 and S3 are compared. For both S1 and S3 the ratios were selected by the subjects (HS). The difference is that for S1 the information is processed by the subjects (HS) whereas for S3 the information is processed by the model (MP_e). In the 2×2 ANOVA (information processing $\times$ environmental predictability) the main effect for information processing was not significant ($F = 1.20$, $p = .28$). The insignificant difference between S1 and S3 shows that when subjects selected their ratios, they were able to utilize all the information in the ratios.

The above four comparisons show that (1) subjects' choice of information is a limiting factor, and (2) while processing is not a limiting factor when subjects process the information which they selected, it does become a limiting factor when subjects are supplied with model-selected information.

Additional Analysis: Models of Man

There is conflicting evidence in the literature as to whether linear models of the decision-maker outperform the decision-maker on whom they are constructed (e.g., see Libby [1976a and 1976b], Goldberg [1976], and Dawes [1979]).

In Lewis et al. [1988] humans and their models had success rates of 45 percent and 42 percent, respectively, in the analyst-selected information condition, and success rates of 44 percent and 44 percent in the model-selected information condition. In the present study linear models of humans were developed for prediction one year and two years from bankruptcy and for information choice by both subject (S2) and environmental model (S5).[5] The average prediction rates for these models are shown in Table 5 and can be seen to be consistent with Lewis et al.

[5] Before the models were developed the ratios were normalized in accordance with Goldberg's [1976] suggestion.

In the present study, when the results were aggregated across the four task categories, the subjects outperformed their model on 38 of 84 occasions, they were even on 20 occasions, and on 26 occasions the model outperformed the subject. While the results were in the same direction as Libby [1976a], matched-pairs t-tests ($t=1.11$, $p=.27$) revealed no significant differences between prediction by subjects and by linear models of man.

Summary and Conclusions

The aim of this study was to extend prior examinations of the comparative effect of information choice and information processing on judgment performance. Abdel-khalik and El-Sheshai [1980] concluded that information choice, rather than information processing was the limiting factor in performance. Consistent with this finding, we also found that sub-optimal selection of cues existed (S6 outperformed S3) and that when subjects selected their own cues there were no advantages in having the model process the information rather than the subjects (S1 equalled S3). However, we extended the Abdel-khalik and El-Sheshai study to consider the performance of subjects given the model-selected ratios (S4). The performance of S4 was not superior to S1 and was inferior to S6. These results are not consistent with the Abdel-khalik and El-Sheshai conclusion that information choice rather than information processing was the limiting factor in performance. Our results extend their study to show that while information processing was not a limiting factor when subjects chose their own ratios, it did become a limiting factor when subjects were given model-selected data. The question of whether these processing difficulties could be overcome by training subjects to become more familiar with the model-selected ratios, or providing feedback to subjects on their performance using these ratios, is not addressed.

Our results concerning the relative performance of S4 were consistent with the findings of Lewis et al. [1988]. However, on the basis of comparisons with a surrogate validation sample they suggest that the superior performance of S6 over other alternatives is due to model overfitting and conclude that there is neither a choice or processing effect. That is, they concluded that there is little difference in the performance of models and humans in selecting and processing data. In our study, we avoid overfitting by developing the model on one sample and applying it to a validation sample to examine human and model performance. We found superior performance of S6 and on the basis of the comparisons made conclude that (1) information choice was a limiting factor, and (2) while information processing was not a limiting factor when subjects chose their own ratios, it does become limiting when they are given model-selected ratios to process.

In conclusion, a number of limitations of the study are noted. First, subjects only chose four cues. As cognitive limitations in processing would be expected to increase as the number of cues increase, processing limitations may play a more important role in more complex situations. Second, only one aspect of task complexity, namely environmental predictability, was manipulated in this study. Wood [1986] outlines a number of other dimensions of task complexity, including the number of cues, that may provide greater insight into the choice versus processing of information issue. Third, the fact that different levels of environmental predictability did not affect the choice versus processing results

may have been a consequence of the difference in environmental predictability between year one and year two data not being sufficient. A stronger manipulation of this variable could be achieved using an alternative task (e.g., prediction of management fraud) or by using data three or four years prior to failure.

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