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## PROBABILITY ASSESSMENT AND PERFORMANCE IN BUSINESS GAME SIMULATIONS

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### ABSTRACT

Business games and simulations have been widely adopted in collegiate business schools. The level of performance by a group in a business simulation has been attributed to many factors. The primary purpose of this paper is to test the hypothesis of a relationship between performance and the group's ability to make good subjective probability assessments.

A business game was used in three graduate level courses in an urban state university. At the end of the term, a performance rank was established for each group. Each group was also given a subjective probability questionnaire. Four measures of probability assessment ability were obtained. A rank correlation was obtained between performance scores and assessment ability for each class and each assessment measures. Statistical significance was found for a number of relationships

### METHOD

A business game simulation, the Business Management Laboratory [2] was utilized for 3 quarters in graduate business courses in a state supported urban university. At the end of each class, a ranking was made on the performance of each firm. The ranking consisted of a composite index of rank orderings of such factors as earnings per share, unit cost of production and debt ratios.

In addition, a subjective probability test was administered to each group participating in the simulation. The questionnaire was answered by each group, as a group. It was administered half way through the quarter so that students had worked together for approximately six weeks. The data obtained were used to calculate measurements for the four subjective probability scores given below:

1. "A resolution" score which is a measure of the assessor's knowledge of events,
2. A "calibration" score which is a measure of the "assessment ability" of the respondent.
3. A "total assessment" or "Brier" score which is the sum of the above two scores,
4. A "COOP" score which indicates how "conservative" or "optimistic" an assessor tends to be in making probability assessments,

A rank ordering was made of each groups' scores for each of the above probability assessment measures. A correlation was made between game performance ranks and the rank orderings of each of the four assessment measures. A Spearman's rank correlation coefficient was used to test for statistical significance.

### SUBJECTIVE PROBABILITY QUESTIONNAIRE

Subjective probability scores were obtained by administering a test which consisted of fifty dichotomous questions. The test was similar to one discussed by Brown, Kahr, and Peterson [1]. Groups were asked to select the best of two possible answers and then to subjectively estimate how certain they were that they had selected the proper answer. Probability assessments were restricted to one of six categories which had assessment values of .5, .6, .7, .8, .9, and 1.0. The following represents a typical question:

Which city is at a higher altitude?

1. Syracuse, New York
2. Salt Lake City, Utah

Numerous scoring rules have been developed to assist in research on probability assessment [3]. In this research we utilized the Brier score [4] which is one of the earlier scoring rules developed. The Brier score has a desirable feature in that the total score may be divided into parts. Each of these parts has a distinct meaning.

The first quantity, resolution, measures the degree of accuracy of the assessors. It is smallest when all predicted events actually occur. It is largest when only 50 percent of the predicted events actually occur. Thus, this quantity can be regarded as a measure of the assessors' knowledge of the events on which the assessments are being made.

The second quantity, calibration, is smallest when the actual percentage correct in any category is exactly equal to the assessed probability associated with that category. Thus, if ten items were each assessed at .80 and eight of the ten occurred, the scoring factor for this category would be zero. The magnitude of this quantity increases with increasing distance between the assessed value and the true percentage correct. This component of the Brier score can be thought of as the component which measures "assessment ability." The calibration score is not useful in measuring the degree of conservatism or optimism in the assessment. It can be modified to represent a measure of assessment ability which takes into consideration the degree of conservatism or optimism of the assessor. We shall call it the COOP (conservatism-optimism) score. A positive score would indicate that ability is less than confidence. Caution should be taken in interpreting the absolute value of the score. A "perfect score" of zero could be obtained by having a positive score which canceled an equal negative score.

### DATA ANALYSIS AND RESULTS

An analysis was made for each of the four types of assessment scores for each of the three classes. A Spearman's rank correlation coefficient was used to test for statistical significance. The results of the correlation analysis are given in Table 1. As can be seen, several significant correlations were found. These include the total or Brier score for classes 1

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and 2 and the calibration score for classes 1, 2, and 3.

TABLE 1

Summary of Rank Correlations

Class	Score	r	p
1	Total	.78	.01
	Resolution	.07	.43
	Calibration	.52	.09
	Coop	.57	.07
2	Total	.80	.05
	Resolution	.60	.14
	Calibration	.70	.09
	Coop	.40	.25
3	Total	.60	.14
	Resolution	.50	.19
	Calibration	.60	.09
	Coop	-.10	.44

### The Brier Score

Rank correlations between Brier scores and performance scores were statistically significant at the .10 level for two of the three classes. This indicates that groups that made better probability assessments tended to perform better in the business simulation. As stated, however, the Brier score can be divided into two components. Therefore, to interpret these results, we must analyze the component parts.

### Resolution

No significant correlations were found for any of the classes when comparing resolution with performance scores. Resolution reflects the degree of accuracy of the assessors. It can be thought of as a measure of the events on which the assessments are being made. Thus, it would be highly unlikely to find any significant correlation between resolution scores and performance scores. Any such significance would imply a relationship between performance and a knowledge of the correct answers to the questions used on the assessment instrument.

### Calibration

Significant correlations were found at the .10 level in all three classes when comparing calibration scores to performance scores. The calibration score can be thought of as a measure of assessment ability. Thus, these results support the idea that those groups that can best deal with the uncertain aspects of the simulation tend to have the best performance scores. This should not surprise us. Courses in business schools continually tell students that business takes place in an uncertain environment. The successful entrepreneur is often the one who can best deal with these conditions of risk.

### COOP

The score is a measure of assessment ability that takes into consideration the degree of conservatism of the assessor. It was included in the analysis to test the thought that firms which tend to be particularly aggressive or conservative will

perform better in the business simulation. No support was given to this hypothesis.

### SUMMARY

Several significant relationships were found on correlations between a group's probability assessment score and their performance in a business simulation. The significant correlations primarily involve the calibration assessment score. This finding should not be totally unexpected. The simulation is interactive. There are random elements involved and uncertainty plays a major role. The groups that perform the best are the one that react well to this uncertainty. The problem for the researcher, of course, is to determine what type of training, knowledge, etc., will help individuals improve their ability in probability assessment.

### REFERENCES

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