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Returns To Information: Experimenting With Farmers*

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A 1975 *Journal* paper by the authors described how business gaming techniques might be used to quantify returns to research information disseminated by land grant universities. A computer game incorporating key managerial decisions in corn and soybean production was developed by the authors (Debertin, *et al.*, 1974). The management game was used as the basis for a laboratory experiment. Participants in the experiment, a group of students in an advanced undergraduate farm management course, were asked to make a series of managerial decisions dealing with the operation of a simulated 600 acre corn and soybean farm. Some of the students were denied access to research information relating to the managerial decisions. Results of the analysis indicated that students who had access to the research information were able to generate significantly greater profits with the game than were students who were denied access to the research information.

The purpose of this paper is to report the results from a second related experiment also conducted in a laboratory environment at Purdue.

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Participants in this experiment were experienced farm managers, not students. The same management game and a similar design was used in both experiments. Hence, comparisons between the performance of the students and performance of the experienced farm managers with the game can be made.

The Management Game

The game used in the laboratory experiment simulated the operation of an Indiana grain farm over a five year period and incorporated managerial decisions basic to corn and soybean production. Each decision included in the model was chosen because research information useful in making the decision was available (Table 1).

The game was constructed such that the management decisions had an impact on gross returns, costs of production, or both. Much of the data used in the construction of the game was obtained from published and unpublished reports by the Purdue agronomy department, and through conversations with Purdue agronomists. Data on costs of production and labor requirements were largely taken from previous extension models in operation at Purdue. Least squares regression was used to derive coefficients not available directly from the research data. Coefficients representing corn and soybean response to fertilizer incorporated in the game were estimated from Purdue agronomy farm data using a Cobb-Douglas production function. A discussion of the procedures used for validation of the game can be found in Debertin *et al.*, (1975). All farmers

Table 1. Decisions Incorporated in the Purdue University Corn-Soybean Production Simulator

1. Combination of corn and soybeans to be planted on 600 acres
2. Soybean variety selection
3. Row width for soybeans and corn
4. P_2O_5 and K_2O applied to soybeans
5. N, P_2O_5 and K_2O applied to corn
6. Date to begin planting soybeans
7. Date to begin planting corn
8. Date to begin harvesting soybeans
9. Date to begin harvesting corn
10. Moisture level to which soybeans are to be artificially dried
11. Moisture level to which corn is to be artificially dried

participating in the experiment were given access to the characteristics of the computer farm including acreage, soil tests, and owned machinery. In addition, prior to making decisions, all farmers were given cash prices of corn and soybeans as of April 1 of the decision period (year) as well as prices of future contracts on April 1. All participants were given feedback from the game. Feedback from the game consisted of results from decisions made in the previous time periods. Included in the feedback was information on yields per acre, prices received, harvest moisture, hired labor, machinery, fertilizer, herbicide and other variable costs, taxes on land and interest on borrowed capital.

Participants In The Experiment

Participants in the laboratory experiment consisted of 39 farmers from 6 of 37 central Indiana counties. The 6 counties were selected at random from the 37 county area. The cooperation of the local county extension agents in the selection of participants was obtained. County extension agents submitted lists of commercial corn and/or soybean producers. Agents were told that the farmers on the list should be representative of commercial producers in the county and that the list should not be dominated by farmers who frequently attended extension meetings and workshops. From the lists submitted by the county agents, the authors randomly selected the participants. Over 90 percent of the farmers initially selected by the researchers chose to participate in the experiment.

A summary of farmer characteristics is presented in Table 2. Two of the 39 participants had previously attended workshops at Purdue in which computerized management models were used. The authors do not argue that the farmers participating in the experiment were a totally adequate representation of Indiana corn and soybean producers. The authors do argue that the farmers in the experiment represented a substantial diversity in age, education, and size of commercial operation. An honorarium of $50 was paid to each farmer participating in the experiment. In addition, prizes of $25, $15 and $10 were given to the three farmers generating the most profits in each group.

Each farmer made a predecision prior to the main experiment. The predecision ensured that the farmers were familiar with the gaming procedures. The predecision served as the basis for the assignment of farmers to the two treatment groups (with and without reserach information). Farmers were ranked according to predecision profits and were assigned to the treatment groups following the same procedure used in the earlier study with the students.

Statistical Results

Mean profits generated per year for the two groups of farmers over the five years of game operation are presented in Table 3. The earlier data from the experiment with the students is also presented for comparison. The data in Table 3 clearly revealed that the farmers did not do as well at managing the simulated farm as did the students.

Table 2. Characteristics of Farmer Participants

Characteristics	Mean	Range
Age (years)	41	21 - 60
Education (years)	12.6	10 - 16
Total Acres Farmed	806	250 - 1800
Total Acres Corn	440	75 - 1200
Total Acres Soybeans	217	0 - 850
Days Worked Off Farm	8.5	0 - 90

Table 3. A Comparison of Profits Generated with the Game for Students and Farmers

	Farm Management Students		Experienced Farmers[a]	
Year (Decision Period)	Without Research Information n = 17	With Research Information n = 16	Without Research Information n = 20	With Research Information n = 19
1	-2,292	-504	-2,746	-3,897
2	14,094	19,316	9,801	12,507
3	17,787	25,267	12,482	14,909
4	4,099	7,177	-152	1,583
5	25,990	28,073	23,977	23,519
Average of 5 Years	11,935	15,866	8,672	9,724

[a]An analysis of data at the conclusion of the experiment revealed a bias when farmers were initially assigned to the two treatment groups. Farmers assigned to the "no information" treatment group averaged $1,244 more profits on the predecision than did farmers assigned to the "information" group. This was primarily because a farmer who was able to generate extremely large profits on the predecision was assigned to the "no information" group, and had no similar counterpart in the "information" group. Hence, returns to information reported here may be understated by $1,244 per decision per farmer.

Farmers without information averaged $8,672 net returns per year over the five decision periods (years), and students without information averaged $11,935 net returns per year over the five decision periods - a difference of $3,263. Farmers with information averaged $9,724 while students with information averaged $15,866 - a difference of $6,142. Moreover, the return to information for the students was $3,931 per decision period, while for the farmers the return to information was $1,052 (see footnote Table 3). The farmer who was able to generate the greatest profits for the five decision periods with the game was a top-notch "real world" farmer as well, and had previously attended a number of Purdue farm management workshops dealing with computerized management aids.

A two way analysis of variance of the data is presented in Table 4. The analysis of variance was performed following the procedures for treating designs with unequal observations in cells as outlined in Scheffee (pp. 113-119).

Information had a significant positive impact on profit levels on three of the five decision periods. Students were able to generate significantly greater profits with the game than were farmers in four of the five decision periods. A significant F ratio on the interaction effect would suggest that students with information were better able to *decode* and *use* information (Welch) in a decision-making context than were farmers. However, the interaction effect was significant in only one of the five decision periods. Hence, it is apparent that information

Table 4. Analysis of Variance of Profits for Students and Farmers

Decision	Condition	F Ratio	Significance
1	Information - No Information	0.02	Nonsignificant
1	Students - Farmers	1.59	Nonsignificant
1	Interaction	0.97	Nonsignificant
2	Information - No Information	5.94	.01
2	Students - Farmers	12.06	.005
2	Interaction	0.63	Nonsignificant
3	Information - No Information	10.57	.005
3	Students - Farmers	28.07	.005
3	Interaction	2.98	.05
4	Information - No Information	2.23	.10
4	Students - Farmers	9.66	.005
4	Interaction	0.18	Nonsignificant
5	Information - No Information	0.18	Nonsignificant
5	Students - Farmers	3.74	.05
5	Interaction	0.57	Nonsignificant
Total	Information - No Information	4.50	.025
Total	Students - Farmers	17.28	.005
Total	Interaction	1.65	Nonsignificant

The model was

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

where

$$\varepsilon_{ijk} = N(o, \sigma^2)$$

has a significant impact on profit levels generated with the game. Students were able to generate significantly larger profits with the game than were farmers. Evidence to suggest that students were better able than the farmers to *decode* and *use* information in a decision-making context was quite weak.

Impact Of Farmer Characteristics On Profit Levels

Least squares regression equations were estimated using profits generated by each farmer with the game as the dependent variable, and the vector of characteristics presented in Table 1 as independent variables. The group to which the farmer was assigned (information or no information) was controlled by a zero-one dummy. A number of alternative model specifications were estimated, employing the information dummy as both a slope and intercept shifter. No consistent evidence of a relationship between any of the farmer characteristics and profit levels was found.

Comments On The Behavior Of The Farmers

As might be anticipated, the farmers appeared to be substantially more uncomfortable working in a laboratory environment than were the students. Attitudes of the farmers toward the experimental situation were quite diverse. Some farmers were highly enthusiastic. Others treated the exercise with polite disinterest. Several of the farmers seemed to be highly troubled by what they considered to be erroneous assumptions used in game construction and were quick to point out deficiencies in the game. Some farmers appeared to make initial decisions consistent with those made on their own "real world" farms, and stayed doggedly with these decisions throughout the experiment. A number of farmers in the "information" group seemed to have a great deal of difficulty interpreting the information. (Tables of information presented to the farmers were primarily taken from extension and research bulletins published at Purdue, although there was little additional explanatory material.) The researchers answered questions dealing with the interpretation of computer feedback and information, but not questions dealing with internal relationships in the game.

Why Did Students Perform Differently Than Farmers?

Why did the students (who, in many ways approximated inexperienced farmers) perform differently than the experienced farmers in the laboratroy environment? One explanation suggests that *observed differences in profit levels may merely reflect marginal returns to an education in a college of agriculture.* The "no information" students may have been exposed to information useful in making game decisions in formal course work prior to the time the experiment was run. However, support for this contention should have been evident in the regression of profits for experienced farmers on farm characteristics, since one of the characteristics used as an independent variable was the education of the farmer. This variable should have been significant: it was not.

A second, perhaps more troublesome explanation is that the students, having worked for nearly four years under academic pressures of a university environment, adapted more readily to the abstractions of the simulated laboratory environment than did the experienced farmers. This line of reasoning would seem to suggest that the students were not in fact better farm managers, but rather were merely better able to play the game.

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