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Information Evaluation in a Competitive Environment: Context and Task Effects

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INFORMATION EVALUATION IN A COMPETITIVE ENVIRONMENT: CONTEXT AND TASK EFFECTS

ABSTRACT

This paper reports the results of an experiment in which subjects assumed the role of division managers in a decentralized firm and made subjective information system choices. Existing subjective information evaluation research is extended by incorporating a two-person competitive environment and investigating the effects of context and task variables on information system choice. Consistent with previous studies, subjects' information system choices indicated misperception of information values, with overvaluation of information occurring more frequently than undervaluation. Deviations from predictions of a game-theoretic model occurred under conditions of state uncertainty. Choices of subjects playing a game with equivalent payoffs, but without state uncertainty, conformed to the model, for the most part. In addition, context did not have an aggregate effect on subjects' information system choices in the settings with state uncertainty. However, alternative presentation modes for information system costs had differing effects on choices across contexts.

INFORMATION EVALUATION IN A COMPETITIVE ENVIRONMENT: CONTEXT AND TASK EFFECTS

Accountants often face the task of evaluating alternative systems for generating "decision-facilitating" information, that is, information which is used to help resolve uncertainty in a problem prior to making a decision [Demski and Feltham, 1976, p. 9]. Accounting researchers have utilized the theory of information economics to develop criteria for the evaluation of such information systems. This theoretical framework assumes that individuals act consistently with the expected utility hypothesis. Experimental research has shown, however, that individuals' subjective evaluations of information systems are not always consistent with the values calculated using information economics [Hilton, Swieringa, and Hoskin, 1981; Hilton and Swieringa, 1981; Schepanski and Uecker, 1983; Uecker, Schepanski, and Shin, 1985].

This paper examines the task of choosing a decision-facilitating information system in a multi-person setting in which individual objectives are in conflict. In the experiment reported here, subjects assumed the role of one of two division managers in a decentralized firm. The subjects interacted with a micro-computer, which played the role of the other manager.

Two features of the current paper distinguish it from previous research. First, it addresses the problem of subjective information evaluation in a two-person environment with conflicting individual objectives. Within such an environment, a private information system may affect the actions of the person without access to the system. Consequently, the value of information may differ from that in a single-person setting or in a multi-person setting where individual objectives are not in conflict [Baiman, 1975]. Current analytical models utilized in accounting research generally assume a multi-person environment with conflicting objectives [Baiman, 1982; Demski and Kreps, 1982]. However, experimental work in accounting has focused on single-person settings [Demski and Swieringa, 1980; Swieringa and Weick, 1982]. In particular, it is not known whether individuals consider strategic implications when deciding whether or not to choose a given information system.

Second, this paper investigates the effect of context and task characteristics on information evaluation behavior. Existing subjective information evaluation research has exclusively incorporated variables directly related to the economic demand value of information. However, the contexts in which information system evaluation problems are encountered often differ. Also, task characteristics, such as the manner in which the payoffs and costs associated with a system are presented, may vary. Results reported in recent studies of other decision problems involving uncertainty [Einhorn and Hogarth, 1981; Payne, 1982] suggest that subjective evaluations of information systems may be subject to context and task effects. These effects may occur instead of, or in addition to, the effects of the variables that enter into the calculation of the demand value of information.

The remainder of the paper is organized as follows. First, the relationship of context and task variables to the information evaluation problem is discussed. Second, the experimental method and hypotheses are described. The third section presents the experimental results. The final section of the paper is a discussion of the results and conclusions.

Theoretical Development

Schepanski and Uecker [1983] and Uecker, Schepanski, and Shin [1985] found that individuals consistently ascribed positive value to information systems, even when the economic demand value of these systems was zero. This research suggests that individuals may perceive the value of information as positive, even when it is not. However, other evidence on whether overvaluation is a general tendency is not clear. Hilton and Swieringa [1982] also found their subjects consistently overvalued information. On the other hand, Hilton, Swieringa, and Hoskin [1982] used a similar elicitation technique and reported that only a portion of their subjects overvalued information.

Inconsistencies between subjective valuations of information systems and their theoretical values may depend on context and/or task variables. Context effects in decision making research are synonymous with content, especially as it relates to the perceived values of the objects in a decision set under consideration [Payne, 1982, p. 386]. The context variable in this study is manipulated by making slight wording changes in an information evaluation problem, while maintaining the same basic problem structure. Task effects are associated with the formal structure of a decision problem. The task variable examined here is the presentation mode for information system costs. Information systems are either presented as "costly" (system costs shown as a separate item) or "costless" (system costs netted out of expected values).

Context Effects

Economic information evaluation models presume that responses should be consistent for problems with identical structures, regardless of the content or framing of the problems. Behavioral researchers assert, however, that content gives meaning to tasks and should not be ignored in trying to predict behavior [Einhorn and Hogarth, 1980, p.61]. Indeed, context effects arising from slight wording changes have been demonstrated in a number of problems involving decision making under uncertainty, such as gambles for money, medical decisions about saving lives, and decisions whether or not to purchase insurance [Kahneman and Tversky, 1979; Tversky and Kahneman, 1981; Hershey and Schoemaker, 1980; Slovic, Fischhoff, and Lichtenstein, 1982]. Since information evaluation is basically a decision to employ a system that will reduce or eliminate uncertainty, it may be subject to similar effects. There are two alternative premises tested in this study with respect to context.

The first premise is that individuals will overvalue information when presented with an explicit information acquisition decision, but not when the problem is presented in more general terms, e.g., as an opportunity to reduce uncertainty. This prediction is based upon the context effects in insurance purchase decisions observed by Hershey and Schoemaker [1980]. In this study, individuals responded differently when a problem was framed as a choice between a sure loss and a lottery with a loss component than when it was framed as a decision to pay an insurance premium to protect against loss. Given the same set of values in both problems, the majority of subjects chose the risky prospect in the gambling problem, while the majority decided to pay the premium in the insurance problem. One of the reasons given for this result is content affects the way individuals view the problems, even though their structure is the same. The insurance purchase may be viewed as the purchase of protection (a valuable good), while the gamble in the lottery context is viewed as preferable to a certain loss [Einhorn and Hogarth, 1980; Slovic, et al., 1982]. A similar context effect may occur in information evaluation problems. Individuals may view information as a valuable good when presented with an information evaluation context, but not in a generalized uncertainty reduction context. This effect may lead to information overvaluation in the first case, and evaluations consistent with economic models in the second.

The alternative premise is that individuals will overvalue information, regardless of context. This is supported by the notion that persons are uncomfortable with uncertain outcomes, thus finding the reduction or omission of uncertainty a useful cognitive simplification mechanism [Hogarth, 1975, p.273]. Any mechanism that is thought to reduce uncertainty may be perceived as valuable, even though it may have no effect on final outcomes [Langer, 1977; Feldman and March, 1981].

Task Effects

The subjective information evaluation research discussed at the beginning of this section focused upon elicitation of demand values. That is, experimenters determined the stated cost at which subjects would be indifferent between a given information system and no information. Within an organization, however, the stated cost of an information system to a user may or may not equal its expected value, or even the actual cost of implementing the system. For example, the costs of producing certain reports may be borne entirely by a data processing department within an organization. Alternatively, each division may be entirely responsible for its own information production costs.[1]

To give a simple example of a stated cost manipulation, consider the following problems (table values are outcomes; utility is linear):

Problem A

	s1 (p=0.6)	s2 (p=0.4)	EU
a1	100	-25	50
a2	-25	25	-5

Problem B

	s1 (p=0.6)	s2 (p=0.4)	EU
a1	100	-25	50
a2	-25	50	5

Assume that perfect information on the state outcome is costless in Problem A and is available for 10 units in Problem B. This allows one to choose a_1 contingent on s_1 and a_2 contingent on s_2, yielding an expected utility of 70. Therefore, the expected utility of perfect information is 10 units for both cases, indicating one should choose to act with information in both even though the stated cost of information is different.[2]

However, individuals may focus on stated cost in ways which are irrelevant, according to economic models [Aschenbrenner, 1978; Payne, 1982, p. 390]. They may use stated cost as an evaluation criterion within a simplified decision process, in lieu of expected value. Individuals following such an approach would set an arbitrary stated cost cutoff point beyond which they will not utilize information, regardless of its expected value. In the above case, assume that a person sets 5 units as their cutoff point. Then, they will act with information in Problem A, but undervalue information in Problem B. One can also construct examples in which this type of decision rule will lead to the overvaluation of information.

A second possibility is that stated cost may affect the decision strategies used to evaluate information systems. When a system is costless or has low stated cost, an individual may decide that expending cognitive resources on detailed analysis of the benefits of the system is not warranted. When stated costs are high, one may make the effort to do an expected value analysis to avoid expenditures on the "wrong" information system. This prediction is derived from a cost-benefit framework for decision strategy selection [Beach and Mitchell, 1978]. Within this framework, stated cost would be viewed as a decision environment characteristic which, in turn, affects task demand, i.e., the perceived need to use analytic decision strategies.[3]

Interaction Between Context and Task Effects

The above discussion of context effects predicts they will occur, regardless of the stated cost of information. This analysis assumes that context effects occur because the wording of the problem affects one's overall perceptions of value in the choice set under consideration. On the other hand, these effects may occur because context changes the way costs are framed [Kahneman and Tversky, 1979; Slovic, et al, 1982]. If the latter proposition is true, then context effects will occur only when the stated cost of information is positive. For example, positive stated cost information may be overvalued in the information evaluation setting, and evaluated according to the economic model or undervalued in the other setting. This is consistent with individuals viewing the cost of information as a payment for obtaining a valuable good in the information evaluation context and as a loss in the uncertainty reduction context. At the same time, information with zero stated cost would be evaluated consistently across contexts.

Method

Experimental Setting

The setting of the experiment is a firm which produces a single product. The firm has two divisions, each headed by a single manager (Manager A and Manager B). (See Appendix A.) The firm's output and the payoffs to the managers depend jointly on the actions of the managers and the outcome of a random state of nature. Each manager has a choice of one of two actions and there are two possible states of nature. Both managers are aware of each other's payoffs and preferences. Manager A has the opportunity to utilize an information system which generates perfect information on the state outcome (η^P). Alternatively, he may choose to act without an information system (i.e., "use" the null information system (η^o).[4] Manager B knows Manager A's information system choice.

In a game-theoretic analysis of the problem, Manager A must make two decisions. First, he must choose between two subgames, one in which he has private information on the state outcome and the other in which he does not. Once he has chosen a subgame, he must choose an action (if acting without information) or a decision rule, which specifies actions to be taken contingent on state outcomes (if acting with information). It can be shown, depending on the payoff sets of both managers, that Manager A's payoff at the Nash equilibrium (NE) point in the private information subgame can be greater than, equal to, or less than that at the NE point in the no information subgame (See Appendix B.). That is, private information can have have positive, zero, or negative expected value for Manager A. This result is in contrast to a single-person or decision-theoretic setting, in which the Fineness Corollary of Blackwell's Theorem states that the value of a finer information system is always greater than or equal to that of a coarser one [Baiman, 1975]. The result is counterintuitive, but the following example illustrates illustrates how the value of information might be negative.

Assume the following scenario: Each manager is responsible for one stage of the production process for a precision tool, with one in charge of the casting department and the other responsible for the machining department. The two actions available to each manager represent high and low levels of effort, while the random parameter represents the quality of the raw materials used in the process. When neither manager has private information, the best strategy for both is to expend a high level of effort. When Manager A has private information, he is able to adjust his effort level contingent on the state outcome. At the same time, the payoffs are such that it is no longer optimal for Manager B to expend a high effort level. This affects the firm's total output and, in turn, lowers Manager A's expected payoff.[5, 6]

Experimental Design

In the experiment, CONTEXT was a between-subjects variable with three levels and COST was a within-subjects variable with two levels. COST was manipulated within subjects in order to investigate whether subjects attended to it as a decision cue, as discussed above. CONTEXT was a between-subjects variable, since changes in problem wording in the course of an experiment might lead subjects to (1) view all presentations of the problem as equivalent, inhibiting framing effects, or (2) speculate on the part of subjects as to the intentions of the experimenter, causing order effects with no clear theoretical interpretation [Keren and Raaijmakers, 1988]. Additionally, the expected value of information (EV) was a within-subjects variable. Levels of COST were zero and positive (0 and 10 units) in the experimental cases. EV levels were negative, zero, and positive (–10, 0, and +10 units).[7] Each of the six resulting cases was repeated five times before the subject was presented with another case, resulting in a total of 30 experimental trials.

All cases with the same stated cost of information were presented together. Order of presentation with respect to stated cost (ORDER) was treated as a between-subjects variable and counterbalanced. The order of presentation with respect to expected value within each level of stated cost was randomized. Ten subjects were presented with each combination of CONTEXT and ORDER, resulting in a total of 60 subjects in the design. (See Figure 1.)

Insert Figure 1 about here.

Experimental Variables

Dependent Variable

The dependent variable in the experiment is the proportion of times over a set of game trials a subject chooses the private information subgame for a given case. Since "Manager A" is the only individual in the experimental scenario able to make such choices, all subjects assumed this role. The role of "Manager B" was taken by the computer. The computer was programmed to play its NE strategies in each subgame, in order to minimize the possibility that subjects playing non-Nash strategies might confound the results.

Independent Variables: CONTEXT and COST

Two different contexts incorporating state uncertainty were used in the experiment. The first context was an information evaluation problem. The parameters (e.g., payoffs and probabilities) in the second context were exactly the same as in the first, except that the problem of information evaluation was presented as a choice between two production processes. One process allowed the manager to make decisions contingent on the observed state of nature, while the other did not. These two contexts will be referred to as the information evaluation and process choice contexts. In the first of these contexts, the stated cost of information (COST) was labelled as such. In the second, it was presented as an additional fixed cost associated with the process allowing contingent choices. (See Appendix A.)

A setting without state uncertainty was also used in the experiment. In this setting, subjects chose a subgame (labelled a "production process") and an action to be taken within the subgame. Payoffs for each outcome in the subgames were the expected values of the outcomes for the settings with state uncertainty. The dependent variable for this setting is the proportion of times over a set of game trials a subject chooses the subgame corresponding to private information in the other settings. This setting will be referred to as the basic game.[8]

The basic game was incorporated into the experiment in order to determine whether individuals playing under conditions of certainty would choose optimal strategies, as defined within a Nash solution framework (See Appendix B.). The basic game therefore serves as a "baseline" against which the settings with state uncertainty can be compared. If optimal subgame choices are observed in the basic game setting, but non-optimal choices are observed in the settings with state uncertainty, one can infer that the non-optimal choices occurred due to the cognitive simplification mechanisms and/or framing effects discussed earlier. If non-optimal subgame choices occur in all settings, additional work is needed to determine: (1) why the deviations from optimality occurred and (2) if the deviations occurred for the same reason in the settings with and without state uncertainty.

Independent Variables: EV

EV was treated as a within-subjects variable, in order to have a basis for testing differences in choice proportions across different levels. These tests provide an indication whether the subjects perceived that the expected value of private information (in the settings with state uncertainty) or the relationship between the NE payoffs for the two subgames (in the basic game setting) differs across cases. Planned comparisons are employed to indicate if these differences (or lack of differences) are affected by context and stated cost.

Since the EV variable has three levels, a set of two orthogonal contrasts can be performed on it. The comparison of primary interest is that between observed values of the dependent variable for positive and negative EV levels. It can be written as:

$$\underline{q}_3 - \underline{q}_1 \qquad (1)$$

where: $\underline{q}_k$ denotes the proportion of times subjects choose to play the private information subgame for cases with EV k

and: k = 1, 2, and 3 denote negative, zero, and positive levels of EV.

For the settings with state uncertainty, this comparison indicates whether subjects perceive the value of information in the positive EV case to be greater than that in the negative EV case, or the same. Interactions between other independent variables and this comparison indicate whether or not these variables have an effect on perceived differences in information value.

The second possible contrast in this set is that between zero EV and the mean of positive and negative EV, or:

$$q_2 - (q_1 + q_3)/2 \quad (2)$$

Given that the value of the first contrast is significantly greater than zero, this contrast gives an indication in the settings with state uncertainty whether the perceived differences between the three levels of information value are equal. If these differences are equal, then the value of the second contrast will not be significantly different from zero. If, however, the difference in choice proportions between zero and positive EV levels is smaller than that between zero and negative EV, the second contrast will be positive. In the remainder of the paper, contrasts of the type specified by Equation 1 will be referred to as EV(1) and those of the type specified by Equation 2 will be referred to as EV(2).

Hypotheses

The basic game setting is used in this study as a "baseline" against which results in the settings with state uncertainty are compared. Therefore, the hypotheses presented below are all based upon predicted interactions of CONTEXT with COST and EV. The hypotheses are grouped together by interaction term in the following discussion.

<u>CONTEXT x COST</u>

COST should only affect subjects' behavior in the settings with state uncertainty. It should have no effect in the basic game setting.

> H_1: The private information subgame choice proportion does not differ across COST levels in the basic game setting, while in the settings with state uncertainty, the choice proportion is greater for zero than for positive COST cases.

<u>CONTEXT x EV</u>

This interaction is an indicator whether misperceptions of information value have occurred in one or both settings with state uncertainty. Misperception of information value is indicated if the contrast between negative and positive EV levels (the 'EV(1)' contrast) for a setting with state uncertainty is significantly smaller than that for the basic game. The CONTEXT x EV(1) interaction may take one of two forms, depending on which of the premises regarding the effect of problem wording presented above is true. If information evaluation behavior is affected by problem wording, then only the EV(1) contrast for the information evaluation setting should be significantly smaller than that for the basic game. On the other hand, if the misperception of information value occurs consistently, regardless of problem wording, the EV(1) contrasts for both settings with state uncertainty should both be significantly smaller than for the basic game setting.

H_{2A}: The EV(1) contrast is smaller in the information evaluation setting than in the basic game.

H_{2B}: The EV(1) contrast is smaller in both the process choice and information evaluation settings than in the basic game.

Rejection of the null for either of these hypotheses indicates either overvaluation and/or undervaluation of information occurred. Therefore, if the null of H_{2A} or H_{2B} is rejected, either H_{3A} or H_{3B} will be tested. However, it is predicted, based on the discussion in the theoretical development section, that significant results will only be found for overvaluation.

H_{3A}: The private information subgame choice proportion at the negative (positive) EV level is greater (less) in the information evaluation setting than in the basic game.

H_{3B}: The private information subgame choice proportion at the negative (positive) EV level is greater (less) in both the process choice and information evaluation settings than in the basic game.

Another type of CONTEXT x EV interaction concerns the relationship between choice proportions for zero and the other EV levels. It is predicted that subjects in the basic game setting will not exhibit a clear preference for either subgame in the cases representing zero EV levels. This results in an EV(2) contrast which is equal or nearly equal to zero. On the other hand, the subjects in either of the settings with state uncertainty may prefer to act with information when it has zero EV, even though in economic terms, they should be indifferent between information and no information at this point. This behavior results in a positive EV(2) contrast, given the EV(1) contrast is in the predicted direction.

H_4: The EV(2) contrast is not significantly different from zero in the basic game, while it is greater than zero in the settings with state uncertainty.

CONTEXT x COST x EV

COST may affect the perceived differences between positive and negative levels of EV, causing them to be greater for positive than for zero stated cost information. This would lead to a COST x EV(1) interaction. However, this effect should not occur without a related CONTEXT x COST x EV(1) interaction, since COST should not have an effect on perceived differences between levels of EV in the basic game setting.

H_{5A}: The EV(1) contrast will be greater for positive than for zero COST cases in the settings with state uncertainty, but not in the basic game setting.

Alternatively, the COST x EV(1) interaction may differ across state uncertainty contexts. As discussed earlier, subjects may view the cost of information as a loss in the process choice context, but as payment for a valuable good in the information evaluation context. If this occurs, the perceived difference between positive and negative levels of EV will be affected by cost only in the process choice context.

H_{5B}: The EV(1) contrast will be greater for positive than for zero COST cases only in the process choice context.

A CONTEXT x COST x EV(2) interaction may arise as follows: Suppose that subjects do act consistently with the expected utility hypothesis when evaluating information at the positive and negative EV levels. Also, they are indifferent as to information choice for zero EV cases with zero COST. However, a cost framing effect occurs at the zero EV level. For positive COST cases, the majority of subjects prefer information in the information evaluation setting and the majority prefer to act without it in the process choice setting. (See Figure 2.) Such an effect is consistent with a shift in reference point due to framing, as described in prospect theory [Kahneman and Tversky, 1979; Tversky and Kahneman, 1981].[9] In this example, the reference point is the status quo in an uncertainty reduction context, while it is one's position after purchasing the information in the information evaluation context.

Insert Figure 2 about here.

H_{6A}: The EV(2) contrast is greater for positive than for zero COST cases in the information evaluation setting.

H_{6B}: The EV(2) contrast is smaller for positive than for zero COST cases in the process choice setting.

Subjects and Procedure

The subjects were students at the University of Texas at Austin. Twenty-one were fourth-year students in the Program in Professional Accounting (PPA), 34 were MBA students, and 5 were first-year accounting Ph.D. students. Subjects were assigned to experimental groups so that the proportion of each type of student was approximately equal in each group. The experiment was run in a computer lab using IBM PCs. There were six separate experimental sessions, with from 6 to 16 subjects completing the experiment at any one time. Subjects participating in the same session were randomly assigned to different experimental treatments.

The experiment was conducted in four phases: (1) preliminary instructions, (2) a quiz on the instructions, (3) practice trials, and (4) the main part of the experiment. At the beginning of each experimental session, subjects were given a set of instructions consistent with their experimental condition and assigned to a computer. The computer displayed the game values and expected values (in the settings with state uncertainty) for the practice trials. Subjects were instructed to read the instructions and examine the computer display, but not to proceed with the experiment.

When all subjects were set up at their computers, the experimenter provided additional brief oral instructions on the use of the IBM keyboard and the conduct of the experiment. The subjects were informed they would be paid in cash at the end of the session and reminded they would be eligible for further prizes, based on their performance. They were instructed to ask any necessary questions during the quiz or practice trials, since no questions were allowed during the main part of the experiment. The subjects were then told to finish reading the instructions and proceed with the experiment when ready.

The quiz consisted of questions designed to test subjects' ability to correctly read the payoff matrices. Each subject completed five practice trials with EV of 0 and COST of 5. After the practice trials, the subjects' point endowment was reset to 100 points and they played the thirty actual trials.

During each trial, the computer prompted the subject for two responses: (1) an information (in the information evaluation setting) or process choice (in the basic game and process choice settings) and (2) an action or production plan choice.[10] In the basic game setting, the computer's ("Manager B's") action and the payoffs to the subject and computer were revealed after the subject's response. In the other settings, a random number representing the state outcome was drawn and revealed to the subject immediately if he chose to act with information.[11] The computer's action and the payoffs to the subject and computer were then revealed. In cases where the subject chose to act without information, the computer's action was revealed first, then the random number, and finally the payoffs. A message on the computer screen notified the subject when payoffs or the stated cost of information were to change on the next trial. After all the experimental trials were completed, the experimenter verified the subjects' point totals and paid them in cash.

Subject payoffs for each trial were stated in points. The conversion rate from points to cash was 1 point = 1 cent. Subjects began the experiment with an initial endowment of 100 points, and accumulated further payoffs on each of the 30 experimental trials. The expected value (or in the basic game setting, the payoff) from making the optimal subgame and action choices for all 30 trials was $16.00. Combined with the initial endowment, this made the expected value for the entire experiment $17.00.[12]

Differences in individual risk preferences were controlled for by designing the experiment so that the <u>ordinal</u> relationship of the expected values for each strategy combination is maintained under a wide variety of positive monotonic transformations of the matrix values. The results can only be affected by risk attitude in the case where subjects are extremely risk-averse or risk-seeking. Such risk attitudes are unlikely to occur, given the range of payoffs from the experiment. Not only do the predictions of the game theory model hold under a wide range of preferences for both players, but they will also hold under a variety of individual <u>beliefs</u> about those preferences. The payoffs for the experiment were also designed so that the predictions of prospect theory would hold, as long as the general form of subjects' value functions remains consistent with prospect theory (risk-aversion for gains and risk-seeking for losses). Therefore, shifts in the value functions postulated by prospect theory should not cause inconsistencies in subject responses during the experiment.[13]

Results

Main Effects

Table 1 is a summary of the proportions with which the subjects chose the private information subgame, broken down by the four independent variables. Table 2 presents the results of the repeated measures MANOVA of the data.[14, 15] The only significant main effects are those for COST ($p = 0.004$) and EV ($p < 0.001$). The dependent variable proportion for the zero COST level is greater for that for positive COST ($q_{zero\ COST} = 0.75$; $q_{pos.\ COST} = 0.67$). The EV(1) contrast is significantly greater than zero ($q_{pos.\ EV} - q_{neg.\ EV} = 0.86 - 0.50 = 0.36$; $p < 0.001$), as is the EV(2) contrast ($q_{zero\ EV} - (q_{neg.\ EV} + q_{pos.\ EV}) / 2 = 0.08$; $p = 0.014$).

Insert Tables 1 and 2 about here.

Hypothesized Interactions

The CONTEXT x COST, CONTEXT x EV, and CONTEXT x COST x EV interactions all were statistically significant ($p = 0.061$, $p < 0.001$, and $p = 0.033$, respectively). Table 3 displays the results of tests of individual hypotheses. All these tests were performed using the Dunn-Sidák multiple comparison procedure [Kirk, 1982, pp. 110-111; Games, 1977].

Insert Table 3 about here.

CONTEXT x COST: The effect of COST was not significant in the basic game and significant ($p = 0.003$) in the information evaluation setting, as predicted by H_1. However, no significant effect was found in the process choice setting, contrary to H_1 (See Figure 3.).

Insert Figure 3 about here.

CONTEXT x EV: Only the EV(1) component of this interaction is statistically significant ($p < 0.001$). Values of the EV(1) contrast are 0.71, 0.16, and 0.22, for the basic game, process choice, and information evaluation settings, respectively (See Figure 4.). The absence of a CONTEXT x EV(2) interaction indicates the EV(2) contrast was consistently positive across contexts, including the basic game setting.

Insert Figure 4 about here.

The EV(1) contrasts for both the information evaluation and process choice settings are both significantly smaller than for the basic game setting ($p < 0.000$), supporting H_{2B}. In addition, there was no significant difference in EV(1) contrasts between the information evaluation and process choice settings. Tests for overvaluation of negative EV information were significant ($p < 0.001$) for both settings with state uncertainty, and tests for undervaluation of positive EV information were significant at $p = 0.014$ and $p = 0.028$ for the process choice and information evaluation settings, supporting H_{3B}. The absolute values of the contrasts for overvaluation tests were larger than for undervaluation tests.

<u>CONTEXT x COST x EV</u>: The COST x EV(1) contrast for a given context is computed as the EV(1) contrast for positive stated cost cases minus the EV(1) contrast for zero cost cases. Therefore, H_{5A} and H_{5B} predict positive values for the COST x EV(1) contrast in the settings with state uncertainty. Values of the COST x EV(1) contrasts are 0.10, –0.25, and 0.08 for the basic game, process choice, and information evaluation settings, respectively. Of these, only the contrast for the process choice setting is significantly different from zero ($p < 0.047$). However, the contrast is negative. These results support neither H_{5A} nor H_{5B}.

The COST x EV(2) contrasts were computed using a similar formula. They are 0.11, –0.19, and –0.07 for the basic game, process choice, and information evaluation settings. Only the contrast for the process choice setting is significantly different from zero ($p < 0.10$). Again, it is opposite the predicted direction and supports neither H_{6A} nor H_{6B}.

Figure 5 shows that COST apparently had a negligible effect on the dependent variable for all levels of EV in the basic game and a consistent effect for all levels of EV in the information evaluation setting. In the process choice setting, choice proportions were nearly equal across EV levels for positive COST cases. For zero COST cases, differences between negative and zero EV levels were observed, but not between zero and positive EV levels.

Insert Figure 5 about here.

Interactions with ORDER

In addition to the predicted interactions, two interactions involving the ORDER variable were significant, ORDER x COST (p = 0.026) and ORDER x CONTEXT x COST x EV (p = 0.027). The significant (p = 0.007) EV(linear) component of the second of these interactions indicates learning effects may have occurred. If learning is taking place, the difference in choice proportions between negative and positive EV cases will be greater in the second half of the experiment than in the first, regardless of ORDER. This leads to an interaction between COST, ORDER, and the linear component of EV.

Further investigation of this interaction showed that the difference in choice proportions between negative and positive EV cases was greater in the second half of the experiment than in the first in the basic game and information evaluation settings, but not in the process choice setting. The difference from the first to the last half of the experiment was statistically significant (p = 0.02) only in the basic game setting. Inspection of the data for the basic game setting (See Table 1.) shows that for all cases with positive EV, the observed choice proportion q was at or near 1.0, regardless of COST or the order of case presentation. However, in the zero cost first order, q was 0.54 for negative EV/zero COST cases (those presented first), while q decreased to 0.08 for negative EV/positive COST cases (those presented last). A similar, but weaker effect occurred in the positive cost first order, where q was 0.32 for negative EV/positive COST cases and 0.14 for negative EV/zero COST cases.

Individual Choice Patterns

An analysis was made of individual choice patterns in order to determine whether they were consistent with the CONTEXT x EV interaction found in the aggregate data. This analysis is broken down by CONTEXT and COST (See Table 4.).[16] Payoff maximization was the most common pattern in the basic game setting. On the other hand, consistently acting with information was the most common pattern in the settings with state uncertainty.[17] When behavior across both COST levels is considered, no subjects in the process choice setting consistently acted as expected payoff maximizers through the entire experiment, and only one subject did so in the information evaluation setting. In contrast, seven subjects in the basic game consistently made choices consistent with payoff maximization throughout the entire experiment. Additionally, three subjects in settings with state uncertainty consistently acted without information--two acted as such only when stated cost was positive and one did so for both levels of stated cost.

Insert Table 4 about here.

To further investigate the CONTEXT x COST x EV interaction, an analysis of individual shifts in choice proportions across COST levels was also made. This was done by performing a separate Wilcoxon matched-pairs signed-ranks test for each level of EV within each CONTEXT, using response proportions for each COST level as the dependent variable. None of the comparisons for the basic game or process choice settings were statistically significant. However, the comparisons for all levels of EV within the information evaluation setting were all statistically significant in the expected direction for negative, zero, and positive EV levels ($p = 0.04$, $p = 0.01$, $p = 0.02$).

Action Choice Data

The analysis thus far has focused on subgame choice. Yet, as discussed earlier, one must evaluate the payoff associated with the optimal action within each subgame (i.e., evaluate the optimal payoffs for acting with and without information) before choosing a subgame (i.e., information system choice) based on that evaluation. It is possible that some of the results presented here occurred because subjects chose the wrong actions in the first phase of the evaluation process. However, dominant actions were chosen 95% of the time in the entire experiment, regardless of subgame choice. This result indicates that subjects in the settings with state uncertainty acted consistently with the Nash solution concept concerning action choices, even though they appeared to ignore strategic considerations when making information system choices.

Slight differences were noted in the proportion of dominant action choices within each CONTEXT (proportions were 0.94, 0.97, and 0.95 for the basic game, process choice, and information evaluation settings), but the differences were not statistically significant. Note also that the proportions of dominant action choices were lowest in the basic game setting, even though the highest proportion of optimal subgame choices occurred here.

Discussion and Conclusions

Context and Task Effects on Information Evaluation

The choices of subjects in both settings with state uncertainty were relatively unaffected by information EV, compared to the "benchmark" of subjects playing under conditions of certainty. Further analysis of choice data indicated this effect occurred primarily because of overvaluation of information with negative EV in both settings with state uncertainty. Undervaluation of information with positive EV was also indicated, but to a lesser extent than overvaluation. Analysis of individual choice data confirmed that overvaluation of information occurred frequently at the individual level in both settings with state uncertainty, although three individuals demonstrated undervaluation. These findings are consistent with previous subjective information studies in accounting, as well as in other areas [Connolly and Gilani, 1982; Connolly and Serre, 1984]. They also consistent with empirical observations which indicate that both over- and underacquisition of information routinely occurs in organizations [Feldman and March, 1981].

The COST task manipulation had no significant effect on behavior in the basic game setting, but did affect behavior in the settings with state uncertainty. These effects differed across the two state uncertainty settings. Within the information evaluation setting, both aggregate and individual analyses showed the effects of COST were in the predicted direction and consistent across EV levels. Consequently, it appears that subjects in this setting attended to COST as a decision cue. In the process choice setting, there was virtually no difference in information choice proportions across EV levels for positive COST cases, while a difference occurred for zero COST cases. At the negative EV level, the choice proportion for positive COST cases was greater than that for zero COST.[18] Analysis of within-subjects choice shifts, however, did not indicate that COST had an effect on individual subject decisions in this setting.

The differing effects of COST across contexts indicate that researchers need to consider context and task variables when designing information evaluation experiments, since the results obtained with one set of variables may not be readily generalizable to others. These effects also have potential implications for those who design and implement information systems for use in organizations. The manner in which a given system and the costs associated with it are presented may cause individuals' subjective evaluations of the system to vary.

Decision Strategies for Information System Choice

A number of subjects in the settings with state uncertainty consistently chose to act with information, regardless of the game parameters. This behavior was not affected by learning from the first to the second half of the experiment. These results suggest that subjects in the state uncertainty settings frequently utilized an "act with information" decision strategy.

One possible explanation for the "act with information" strategy is based on the cost-benefit framework [Beach and Mitchell, 1978; Christensen-Szalanski, 1978, 1980] discussed earlier. That is, subjects consciously decided the costs of implementing complex decision strategies outweighed the benefits to be gained from their use [Payne, 1982, p. 383]. A second explanation is that acting with information is a metarule or metaheuristic, which is used to generate lower-level strategies [Einhorn, 1980, p.4]. Kleinmuntz and Thomas [1987] propose that decision makers may employ metaheuristics as an alternative to calculative rationality in choosing strategies for specific tasks. They describe the use of an infer-then-act metarule, which is consistent with the use of uncertainty avoidance mechanisms discussed in the second section of the paper. It is not yet known which factors affect the use of metaheuristics. They may be "hard-wired", that is, individuals may have a repertoire of metarules which are automatically called upon when facing certain task situations. Otherwise, their use may be subject to a simplified choice process, in which the input includes decision cues such as context.

Extensions of this study which incorporate concurrent protocols can indicate whether individuals consciously select simplified decision strategies [Payne, 1982, p. 397]. They also would show how and when they incorporate stated information cost into their decision making processes. Finally, they would provide evidence as to individuals' awareness of the importance of the other player's actions in determining their own payoffs.

Information Evaluation and Strategic Behavior

As stated in the introduction, a factor which differentiates the present study from previous work is that it was conducted in a multi-person environment, with conflicting individual objectives. An important aspect of the results is that subjects presented with a game with no state uncertainty conformed more closely to the predictions of the Nash model than those playing a game with state uncertainty and equivalent payoffs. This occurred even though controls for differing risk attitudes were incorporated into the experiment.

However, behavior in the basic game setting was not entirely consistent with that predicted by the Nash model. The overall proportion of choices of the "information" subgame in the basic game setting in the "negative EV" case was 0.27, rather than zero. Further analysis of the data indicated learning effects in the basic game, which were not observed in the settings with state uncertainty. The results suggest that in the basic game, subjects may have started out with the belief that their opponent would choose actions at random, rather than in any strategic fashion. Once they were able to observe how their opponent played, they shifted their own strategies to maximize their payoffs, given this new knowledge.

The learning behavior observed in the basic game may have been induced by factors associated with this particular experiment. These include the fact the subjects knew they were playing against a computer, as well as the wording of the experiment instructions, which emphasized the fact the subject's opponent makes choices without knowledge of the subject's actions. Either or both of these factors could lead subjects to believe "Manager B's" choices occurred at random. An alternative explanation is that inferring predicted actions through experience commonly occurs in strategic settings. This implies a weaker set of behavioral assumptions than those used in the Nash solution concept, which presumes that all players are able to simultaneously infer each others' optimal strategies [Bernheim, 1984; Pearce, 1984; Tan and Werlang, 1986]. Investigation of strategic behavior under alternative sets of assumptions is a fruitful area for future analytical and experimental research.

The finding that subjects in the settings with state uncertainty were, for the most part, unable to discern the strategic implications of subgame (i.e., information system) choice suggests the presence of uncertainty is an important task variable in competitive settings, from a behavioral point of view. However, exactly how and why uncertainty affected subjects' decisions is not clear. Also, the findings of this study do not indicate that deviations from economic rationality will always occur in competitive settings with state uncertainty. Here, contextual manipulations did not affect the extent to which subjects facing uncertainty acted consistently with an economic model. However, other situations exist in which individuals do use information in a strategic fashion [Ponssard, 1981, pp. 96-100].

Demski and Swieringa [1980] have speculated about the importance of framing in multi-person settings, raising questions about: (1) whether framing and choice processes differ when nature alone and/or choices of other individuals affect the perceived outcomes, and (2) whether behavior in two competitive settings with identical structure, but varying contexts, is dissimilar. The present study has confirmed these speculations to a limited extent, showing that some of the same framing effects and decision strategies that occur in single-person settings also occur in a two-person setting. Additionally, it has shown that the presence of state uncertainty has a significant effect on individual choice behavior. However, further research is necessary to determine which context and task features cause individuals to ignore the strategic implications of actions within a multi-person environment in some cases and act as if they were aware of these implications in others.

APPENDIX A
Excerpts from Instructions to Subjects

The instructions below are for the settings with state uncertainty. Places where the wording differs according to context are indicated with brackets, [ ], with the wording for the process choice setting shown first and the information evaluation setting shown second.

This is an experiment in management decision making. You will play the role of a division manager in a company ("Manager A"). There is one other division manager in the company ("Manager B"). The role of the other manager will be played by the computer. It will be programmed to act as if it were a human subject. You and Manager B will receive payoffs during each period of the experiment. You cannot by yourself control these payoffs. Rather, payoffs to you and Manager B will depend on the actions taken by both of you and on a random outcome.

The payoffs are stated in points. The points are convertible into cash at the end of the experiment at the rate of 100 points = 1 dollar. You will be credited with 100 points, or 1 dollar at the beginning of the experiment and payoffs or losses from each period will be added or subtracted from your account at the end of each period. The experiment will last a large number of periods, so you have the opportunity to earn a significant amount in addition to your initial stake. If your accumulated balance becomes negative at any time, continue to play, as there will likely be enough periods remaining to accumulate a positive balance again.

The sequence of events <u>during each period</u> is:

1. You and Manager B will be presented with a display of outcome payoffs and expected payoffs similar to the one currently on the screen.

2. You will choose [a production <u>process</u>] [whether or not to obtain information on the random outcome].

3. Manager B will be notified [of your choice of production process] [whether or not you have decided to obtain information].

4. You will choose:

--a production action, if you have chosen [Process X] [to act without information]

or

--a production plan, if you have chosen [Process Y] [to act with information]

and Manager B will choose a production action. Manager B will not know which production action or plan you have chosen at the time he makes his choice.

5. The computer's random number generator will generate a number between 1 and 100. If the number is from 1 to 60, Outcome 1 has occurred. If the number is from 61 to 100, Outcome 2 has occurred. The random number and outcome will be revealed to you at this point is you have chosen [Process Y] [to act with information]. Note that Manager B always chooses his action without knowledge of the random number or outcome.

6. The following will then be revealed to both you and Manager B:

a. Manager B's production action. (Your production action is revealed to Manager B at this point.)

b. The random number and outcome which occurred (if you chose [Process X] [to act without information]).

c. Your and Manager B's payoffs and losses.

7. Your payoff (loss) for the trial will be added (subtracted) from your accumulated point total. . .

. . .The lower part of the EXPECTED PAYOFFS section shows the expected payoffs for each combination of your production plan and Manager B's action choice if you [choose Process Y] [elect to obtain information on the random outcome]. A production plan specifies which actions will be taken, depending on the realized outcome. Note that the first two production plans specify that the same action will be taken regardless of the outcome, [just as with Process X] [just as if one were acting without information]. The second two plans allow you to specify actions to be taken contingent on the realized outcome. Plan 3 specifies that Action 1 be taken when Outcome 1 occurs and Action 2 be taken when Outcome 2 occurs. Plan 4 specifies that Action 2 be taken when Outcome 1 occurs and Action 1 be taken when Outcome 2 occurs.

At the time Manager B chooses his action, [he will know which process you have chosen], [he will know whether you have chosen to act with or without information], but will not know your production action or plan choice or which outcome has occurred. Note that Manager B is always restricted to the choice of a single action regardless of whether you choose [Process X or Process Y] [to act with or without information].

[Process Y] [Information on the random outcome] will have [an additional fixed cost] [a cost] associated with it in certain periods of the experiment, and [not have this additional cost] [be costless] in others. [When there is an additional cost] [When information has a cost and you decide to use it], its cost will be subtracted from the gross payoff for the trial. The [amount of additional cost] [cost of information] is displayed next to the heading ["PROCESS Y"] ["WITH INFORMATION"] on the computer display. This amount has been subtracted from your expected payoff amounts in the [PROCESS Y] [WITH INFORMATION] section. . .

. . .In summary, you must make two decisions during each period: (1) [which production process is to be used] [whether you wish to act with or without information on the random outcome] and (2) which production action or plan you wish to carry out. Manager B must choose a production action. Manager B knows all the data regarding payoffs and outcome probabilities displayed on the computer screen at the beginning of each period (i.e., the data currently displayed on the screen). At the time Manager B makes his choice, he <u>will</u> know [your process choice] [whether or not you are acting with information]. But, he will <u>not</u> know your production action or plan. At the end of each period, both you and Manager B will be presented with the following data: (1) the outcome which occurred, (2) the actions taken by both of you, and (3) the payoffs earned by both of you.

Your payoffs and the [additional fixed cost for Process Y] [cost of information] will generally remain the same from period to period. They will change occasionally, however. The computer will give you a message when the payoffs and/or costs do change. . .

APPENDIX B
Computation of Information Value in the Experiment

The experimental setting can be characterized as a game of imperfect, but complete information with an uncertain parameter. Imperfect information indicates the players are unable to observe each others' action choices. Complete information indicates the players are aware of all the rules of the game, including each others' payoffs and preferences [Schotter and Schwödiauer, 1980]. The game can also be thought of as a reformulation of a game of incomplete information, which is a game characterized by uncertainty about one or more game parameters [Harsanyi, 1967, 1968].

In the following discussion, Action 1 is denoted a_1 for Manager A and b_1 for Manager B; Action 2 is denoted a_2 for Manager A and b_2 for Manager B. The two possible states of nature are denoted s_1 and s_2. Figure A2 shows the extensive form of the game facing the two managers, based on the parameters in Figure A1. The game can be decomposed into two subgames, labelled "informed" and "not informed" in Figure A2. Manager A's decision problem on his first move is to determine which of the two subgames will yield him a higher payoff.

Insert Figure A1 and A2 about here.

The game can be more easily analyzed by examination of its strategic form (See Figure A3.). Examination of the no information subgame shows that a_1 is a dominant strategy for Manager A, since 50 > 25 and 36 > –50. A similar analysis shows that b_1 is a dominant strategy for Manager B. The strategy pair (a_1, b_1) is thus a Nash equilibrium (NE); that is, a pair of strategies such that no player, assuming the other is committed to his strategy, can increase his payoff by unilaterally changing strategies [Shubik, 1982, p.240].

Insert Figure A3 about here.

The strategic form of the private information subgame shows that Manager A has a choice of one of four decision rules. For a decision rule a_{ij}, the subscript i indicates Player 1's actions when s_1 occurs; j indicates his actions when s_2 occurs. For example, a_{12} means "choose a_1 when s_1 occurs; choose a_2 when s_2 occurs". The decision rule a_{12} dominates all of Manager A's other decision rules. Manager B still must choose between one of two actions as in the no information case. Manager B's best response to a_{12} is b_2, which makes (a_{12}, b_2) a NE.

The expected value of private information to an individual is his expected payoff in the private information case, minus his expected payoff in the no information case. In the present example, the value of private information to the informed manager is 40 – 50, or –10. Information also has zero value to the uninformed manager here. The negative value of private information for the informed manager is in contrast to a single-person or decision-theoretic setting where the Fineness Corollary of Blackwell's Theorem states that the value of a finer information system is always greater than or equal to that of a coarser one.

This analysis presumes that the game is only played once. In the experiment, the game was played repeatedly over multiple trials. The outcome of a repeated game may differ from that of a single play game under certain circumstances [Luce and Raiffa, 1957]. Specifically, if the NE point in single plays is not Pareto-optimal, the players can achieve gains through cooperation in repeated plays. However, the games used in the experiment were designed so that the single-play optimal solutions were also optimal for both players in repeated plays.

Footnotes

[1]Yet another possibility is the allocation of data processing costs from a service department to individual units. For discussions of the optimal allocation of such costs, see, for example, Zimmerman [1979] and Demski [1980].

[2]For nonlinear utility functions, the expected value of information would differ. However, for nearly all types of utility functions, perfect information should be preferred to no information. The only exception is that extreme risk preferrers may prefer to act without information in Problem B.

[3]See Waller and Mitchell [1983] for an investigation of the relationship between task demand and qualitative aspects of accounting information systems.

[4]Note that a choice task was used here, rather than the rating task commonly used in existing subjective information evaluation research. This was done in order to investigate the hypothesized task effects of information system cost presentation discussed above.

[5]Note that this example is included for illustrative purposes only. The setting presented to subjects was an abstract one, in order to avoid introducing factors which might confound the hypothesis tests [Swieringa and Weick, 1982].

[6]The payoffs for the experiment were determined without regard to whether they represented optimal contracting arrangements for the managers. While this limits the external validity of the experiment in some respects, it does not affect the principal objectives of the study, which are to determine the effects of task and context variables on subjects' information system evaluations.

[7]The payoffs for the case with EV of –10 and zero COST are shown in Appendix A (See Figures A1 and A3). Other levels of EV were obtained by changing Manager A's payoff for the outcome (a_2, b_2) in State 2. For positive COST cases, 10 units were subtracted from all of Manager A's payoffs in the private information subgame.

[8]The term CONTEXT will be used in the remainder of the paper to refer to both the settings with uncertainty and that without. There is no "expected value" of information in the basic game setting, since it is played under conditions of certainty. However, for ease of exposition, the term EV will be used to indicate the difference between payoffs at the Nash equilibrium points in the subgames corresponding to private information and no information in the basic game setting. Also, these subgames will be referred to as "private information" and "no information", even in the basic game setting.

[9]A proof is available from the author.

[10]The subjects always chose actions in the basic game setting and when they were acting without information in the other settings. When they chose to act with information in the settings with state uncertainty, they were told to choose a production plan, which is the same as the decision rules discussed in Appendix A.

[11]The random numbers ranged from 1 to 100. Random numbers from 1 to 60 indicated the occurrence of State 1, while numbers from 61 to 100 indicated State 2 had occurred.

[12]Additionally, the top and second place subjects in each CONTEXT treatment group were awarded prizes of $100 and $25.

[13]Proofs are available from the author.

[14]The proportions were transformed before analysis using an arcsin transformation (Neter and Wasserman, 1974, p.507) in order to avoid the problem of unequal variances across different levels of the dependent variable.

[15]The data meet the compound symmetry assumptions required for a univariate repeated measures ANOVA, however, the multivariate approach was used here to facilitate tests of the interaction hypotheses. With repeated measures MANOVA, the set of orthogonal contrasts on EV is treated as a vector of dependent variables. For each effect involving EV which MANOVA indicates to be significant, separate ANOVAs are done on each individual contrast [Bock, 1975, Ch. 7; La Tour and Miniard, 1983]. The multivariate approach is generally less powerful than the univariate. As a check, univariate tests were run on the data. No differences were found between the two approaches as to the significance of main effects or interactions .

[16]The classifications for each level of cost were defined according to private information subgame choice proportions as follows: payoff maximization--0.2 or 0.0 on the negative EV case, 0.8 or 1.0 on the positive EV case, and any proportion on the zero EV case; always preferring information--0.8 or 1.0 on all cases. No meaningful subclassifications could be drawn within the "other" category, except for three subjects who consistently acted without information.

[17]The differences across contexts in relative proportions of choice patterns are statistically significant for both zero stated cost ($\chi^2_{(4)} = 8.75$; $p = 0.07$) and positive stated cost ($\chi^2_{(4)} = 29.78$; $p < 0.0001$).

[18]Connolly and Serre [1984] found a similar result, where a significant proportion of subjects presented with decision cues with equal validity but different costs actually chose the cues with the higher cost.

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Table 1
Proportion of Choices–Private Information Subgame

Breakdown by Cells

Zero Cost

Order	Context	Negative EV	Zero EV	Positive EV
Zero	Basic Game	0.54	0.80	1.00
Cost	Process Choice	0.50	0.88	0.94
First	Info. Evaluation	0.80	0.94	0.88
	Mean	0.61	0.87	0.94
Positive	Basic Game	0.14	0.72	1.00
Cost	Process Choice	0.58	0.82	0.70
First	Info. Evaluation	0.58	0.76	0.86
	Mean	0.43	0.77	0.85
Mean	Basic Game	0.34	0.76	1.00
Values	Process Choice	0.54	0.85	0.82
for Contexts	Info. Evaluation	0.69	0.85	0.87
Overall Mean		0.52	0.82	0.90

Positive Cost

Order	Context	Negative EV	Zero EV	Positive EV
Zero	Basic Game	0.08	0.78	0.94
Cost	Process Choice	0.78	0.68	0.80
First	Info. Evaluation	0.46	0.66	0.74
	Mean	0.44	0.71	0.83
Positive	Basic Game	0.32	0.78	0.98
Cost	Process Choice	0.66	0.76	0.70
First	Info. Evaluation	0.52	0.58	0.76
	Mean	0.50	0.71	0.81
Mean	Basic Game	0.20	0.78	0.96
Values	Process Choice	0.72	0.72	0.75
for Contexts	Info. Evaluation	0.49	0.62	0.75
Overall Mean		0.47	0.71	0.82

(Table continues.)

Table 1, continued

Averaged Across EV and COST

Means across EV levels

Order	Context	Negative EV	Zero EV	Positive EV
Zero	Basic Game	0.31	0.79	0.97
Cost	Process Choice	0.64	0.78	0.87
First	Info. Evaluation	0.63	0.80	0.81
	Mean	0.53	0.79	0.88
Positive	Basic Game	0.23	0.75	0.99
Cost	Process Choice	0.62	0.79	0.70
First	Info. Evaluation	0.55	0.67	0.81
	Mean	0.47	0.74	0.83
Mean	Basic Game	0.27	0.77	0.98
Values	Process Choice	0.63	0.79	0.79
for Contexts	Info. Evaluation	0.59	0.74	0.81
Overall Mean		0.50	0.76	0.86

Means across COST levels

Order	Context	Zero Cost	Pos. Cost
Zero	Basic Game	0.78	0.60
Cost	Process Choice	0.77	0.75
First	Info. Evaluation	0.87	0.62
	Mean	0.81	0.66
Positive	Basic Game	0.62	0.69
Cost	Process Choice	0.70	0.71
First	Info. Evaluation	0.73	0.62
	Mean	0.68	0.67
Mean	Basic Game	0.70	0.65
Values	Process Choice	0.74	0.73
for Contexts	Info. Evaluation	0.80	0.62
Overall Mean		0.75	0.67

Averaged Across All Cases

Order	Context	Mean Choice Proportion
Zero	Basic Game	0.69
Cost	Process Choice	0.76
First	Info. Evaluation	0.75
	Mean	0.73
Positive	Basic Game	0.66
Cost	Process Choice	0.70
First	Info. Evaluation	0.68
	Mean	0.68
Mean	Basic Game	0.67
Values	Process Choice	0.73
for Contexts	Info. Evaluation	0.71
Overall Mean		0.71

Table 2
Multivariate Analysis of Variance of Proportions of Private Information Subgame Choices

Source of Variation	Wilks Lambda	F	p
CONTEXT		0.20	0.817
ORDER		0.80	0.375
ORDER x CONTEXT		0.05	0.943
COST		9.06	0.004
CONTEXT x COST		2.95	0.061
ORDER x COST		5.23	0.026
CONTEXT x ORDER x COST		1.34	0.270
EV	0.33	53.05	0.000
EV(1)		106.46	0.000
EV(2)		6.40	0.014
CONTEXT x EV	0.50	10.97	0.000
Context x EV(1)		26.40	0.000
Context x EV(2)		1.11	0.337
ORDER x EV	1.00	0.02	0.982
Order x EV(1)		0.03	0.866
Order x EV(2)		0.01	0.942
CONTEXT x ORDER x EV	0.92	1.16	0.332
Context x Order x EV(1)		1.19	0.312
Context x Order x EV(2)		0.94	0.397
COST x EV	0.98	0.50	0.611
Cost x EV(1)		0.25	0.619
Cost x EV(2)		0.96	0.332
CONTEXT x COST x EV	0.82	2.74	0.033
Context x Cost x EV(1)		3.66	0.032
Context x Cost x EV(2)		3.26	0.046
ORDER x COST x EV	0.95	1.31	0.277
Order x Cost x EV(1)		2.67	0.108
Order x Cost x EV(2)		0.29	0.595
ORDER x CONTEXT x COST x EV	0.82	2.86	0.027
Order x Context x Cost x EV(1)		5.53	0.007
Order x Context x Cost x EV(2)		1.90	0.160

Table 3
Analysis of Predicted Interaction Contrasts

Contrast	t	p
H_1: ($q_{zero\ COST} - q_{pos.\ COST}$) for each context		
Context (1)	1.25	0.518
Context (2)	0.32	0.985
Context (3)	3.65	0.003
H_{2A} and H_{2B}: Comparison of EV(1) contrasts across contexts		
Context (1) – Context (2)	6.53	0.000
Context (1) – Context (3)	6.03	0.000
Context (2) – Context (3)	-0.50	0.999
H_{3A} and H_{3B}:		
Comparison of $q_{neg.\ EV}$ across contexts		
Context (2) – Context (1)	5.57	0.000
Context (3) – Context (1)	5.18	0.000
Comparison of $q_{pos.\ EV}$ across contexts		
Context (2) – Context (1)	-3.25	0.014
Context (3) – Context (1)	-2.97	0.028
H_{5A} and H_{5B}: COST x EV(1) contrasts for each context		
Context (1)	0.97	0.705
Context (2)	-2.49	0.047
Context (3)	0.65	0.889
H_{6A} and H_{6B}: COST x EV(2) contrasts for each context		
Context (1)	1.36	0.449
Context (2)	-2.22	0.087
Context (3)	-0.83	0.795

Context (1): Basic Game Setting
Context (2): Process Choice Setting
Context (3): Information Evaluation Setting

Table 4
Tabulation of Subject Choice Patterns by CONTEXT and COST

	Basic Game Setting	Process Choice Setting	Information Evaluation Setting	Totals
Zero Stated Cost				
Payoff Maximizing	10	5	4	19
Always Preferring Pvt. Info. Subgame	2	8	10	20
Other	8	7	6	21
Positive Stated Cost				
Payoff Maximizing	15	1	3	19
Always Preferring Pvt. Info. Subgame	1	12	7	20
Other	4	7	10	21

Figure 1
Schematic Diagram of Experiment

			Within-Subjects Variables (Case Characteristics)					
Stated information cost:			Zero			Positive		
Expected value of information:			Negative	Zero	Positive	Negative	Zero	Positive
Between-Subjects Variables								
Order	Context	Subjects						
	Basic Game	1 . . 10						
Zero cost first, then positive cost	Process Choice	11 . . 20						
	Information Evaluation	21 . . 30						
	Basic Game	31 . . 40						
Positive cost first, then zero cost	Process Choice	41 . . 50						
	Information Evaluation	51 . . 60						

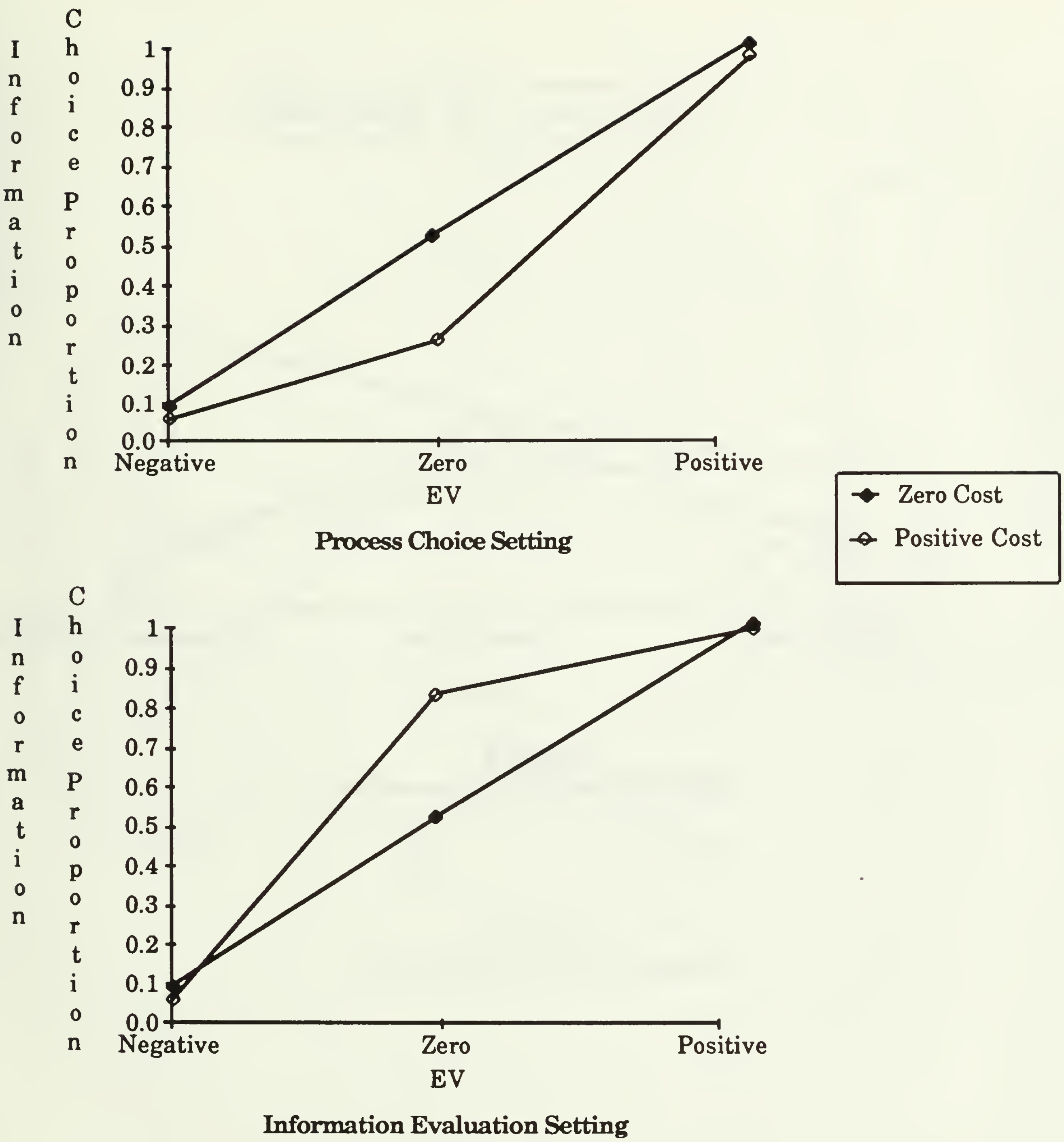

Figure 2
Possible CONTEXT x COST x EV(2) Interaction

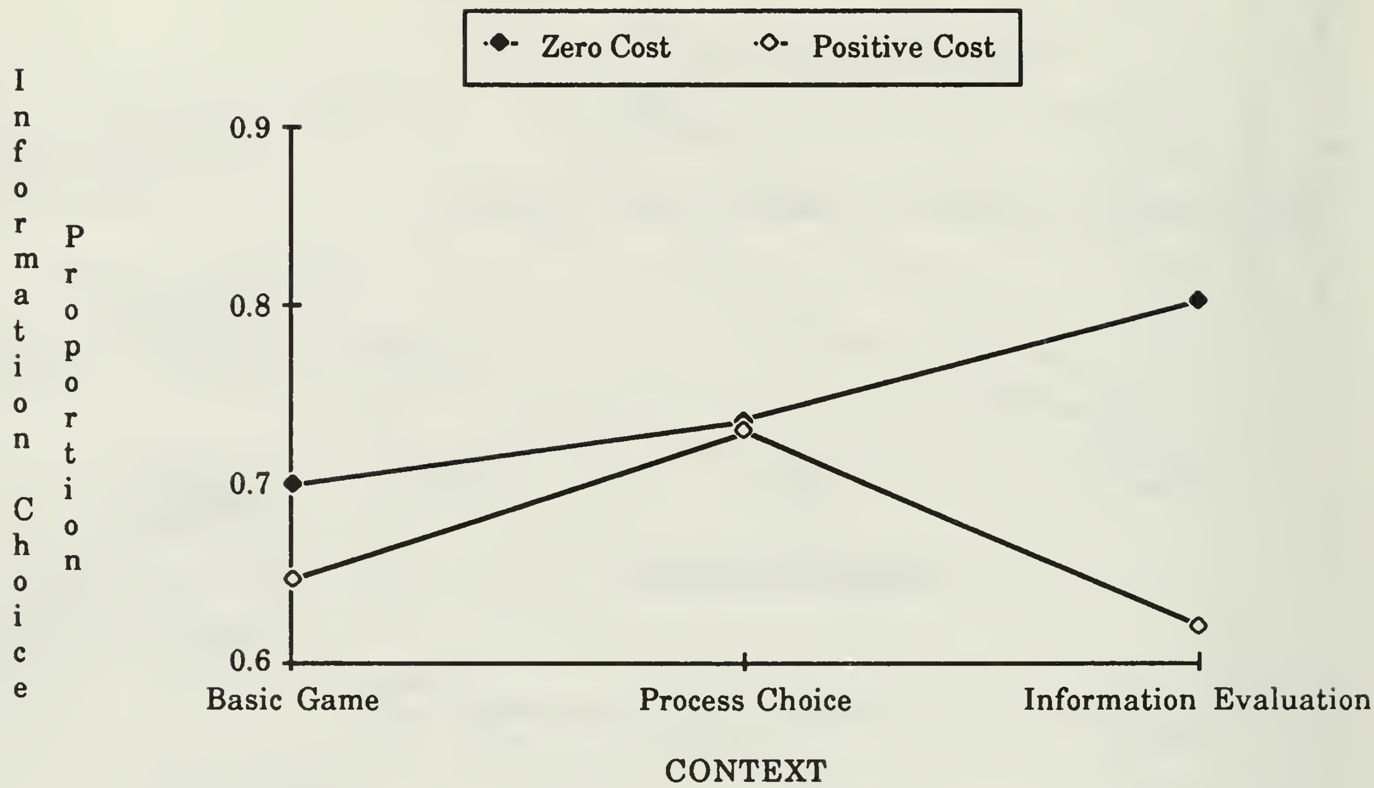

Figure 3
CONTEXT x COST Interaction

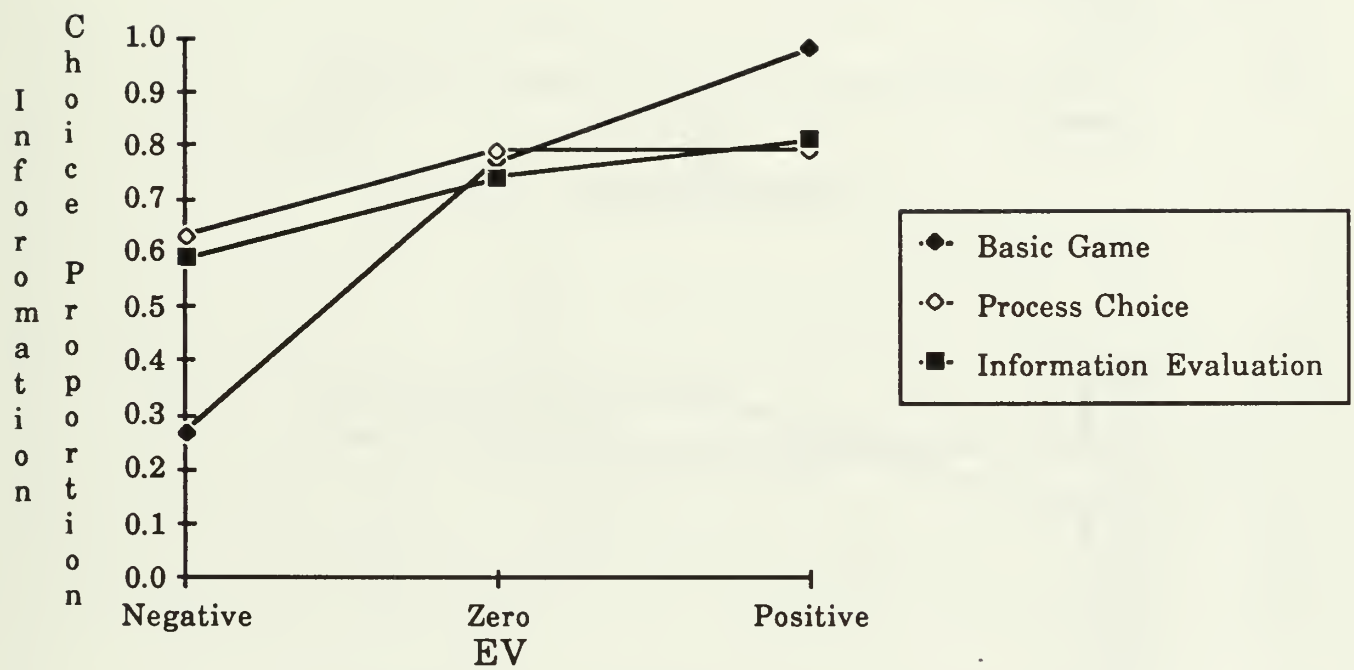

Figure 4
CONTEXT x EV Interaction

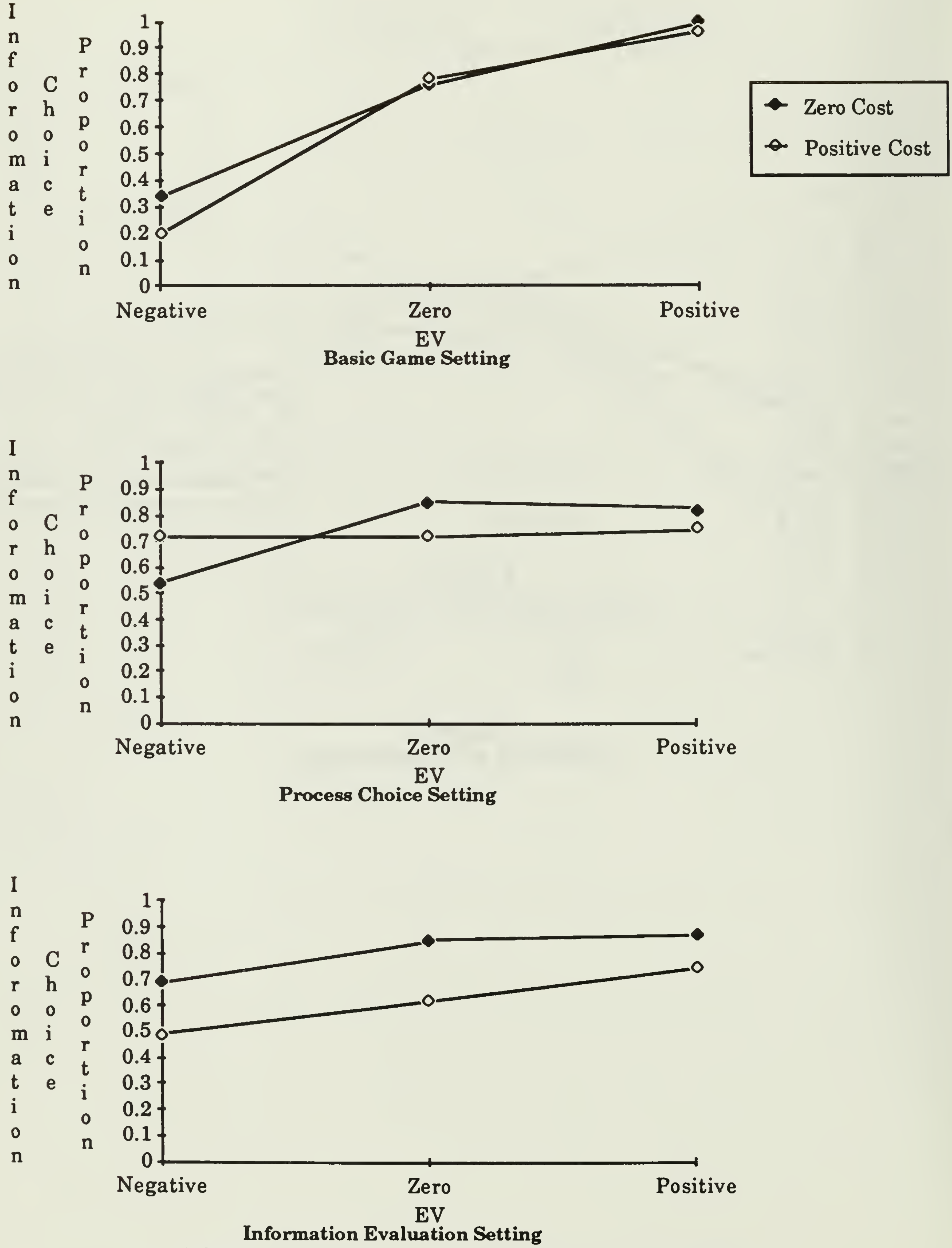

Figure 5--COST x EV Interaction: by CONTEXT

State 1 p(s1) = 0.6

	b1	b2
a_1	(100, 80)	(100, 20)
a_2	(-25, 70)	(-50, -50)

State 2 p(s2) = 0.4

	b1	b2
a_1	(-25, 10)	(-60, 80)
a_2	(100, -50)	(-50, 100)

Figure A1

Game Parameters

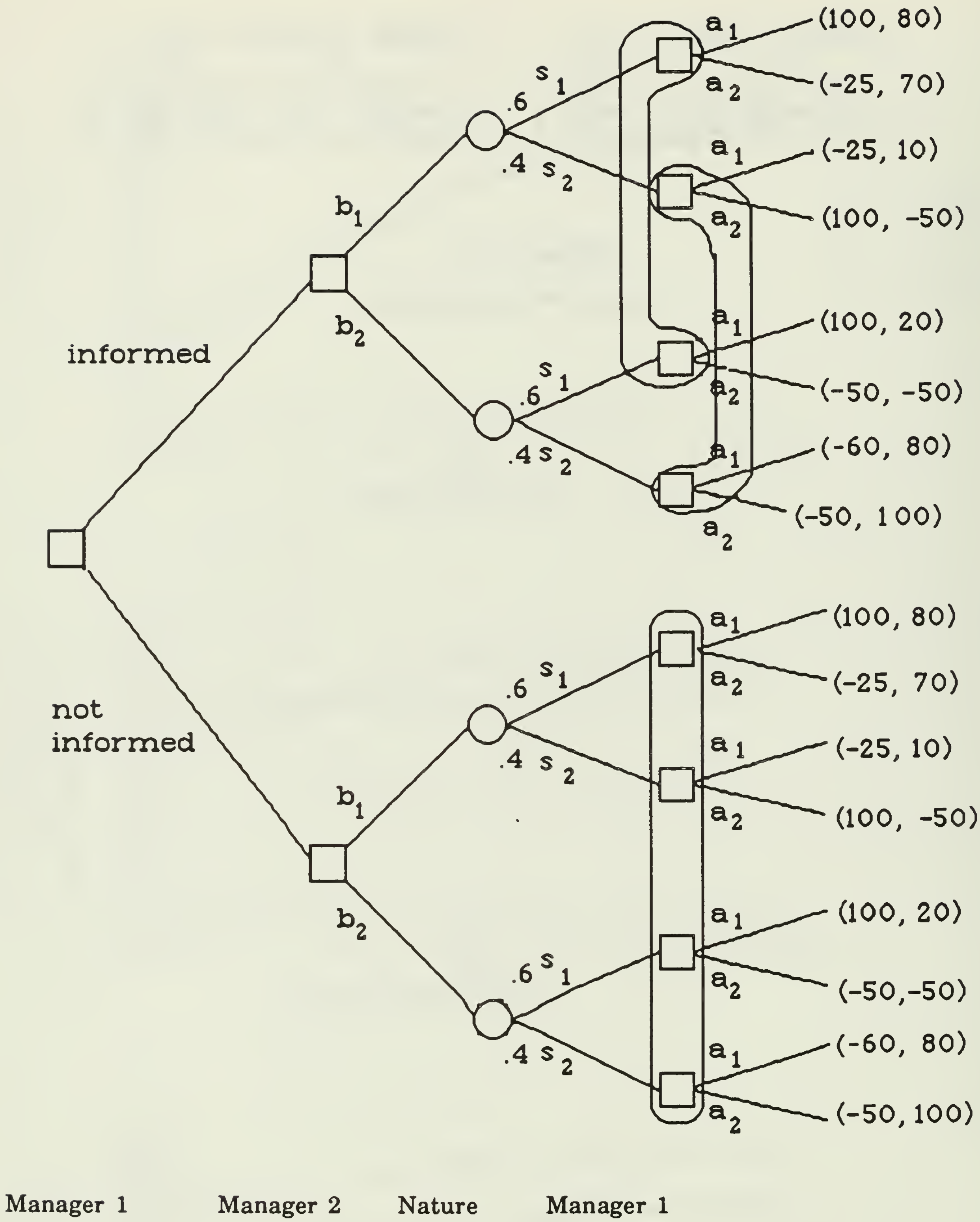

Figure A2
Extensive Form of the Game

	b_1	b_2
a_1	(50, 52)	(36, 44)
a_2	(25, 22)	(-50, 10)

No Information Subgame

	b_1	b_2
a_{11}	(50, 52)	(36, 44)
a_{12}	(100, 28)	(40, 52)
a_{21}	(-25, 46)	(-54, 2)
a_{22}	(25, 22)	(-50, 10)

Private Information Subgame

Figure A3

Strategic Form of the Game