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# De-Escalation of Commitment in Oil Exploration: When Sunk Costs and Negative Feedback Coincide

Howard Garland
Department of Business Administration
University of Delaware

Craig A. Sandefur
Department of Management
University of Texas at Arlington

Anne C. Rogers
Southern Union Exploration Company, Dallas, Texas

Three experiments were conducted to examine the combined effects of sunk costs and negative feedback on decisions to escalate or withdraw from a petroleum-exploration venture. In Experiments 1 and 2, petroleum geologists responded to scenarios in which from 1 to 4 dry wells had been drilled. Number of dry wells was manipulated both between subjects (Experiment 1) and within subjects (Experiment 2). Contrary to earlier research, the higher the sunk cost (i.e., the greater the number of dry wells), the less likely geologists were to authorize funds to continue with the venture and the lower their estimates were of the likelihood that the next well would be productive. In Experiment 3, university students responded to our oil-drilling scenarios. Results of this experiment were in the same direction as that found with the geologists but were considerably weaker and were not statistically significant.

A growing body of research suggests that individuals often allocate additional resources to an ongoing project despite information suggesting that the project is not likely to produce its intended outcomes. Much of the data generated on this subject can be traced to Staw's (1976, 1981) work on escalation of commitment. Staw's original research in this area was based on a model of decision making in which negative feedback following the choice of some action stimulates concern for the justification of that choice. This concern results in persistence with or escalation of the previously chosen action in the hope that future positive outcomes might vindicate the original choice.

A related area of research on entrapment (Brockner, Shaw, & Rubin, 1979; Rubin & Brockner, 1975) also suggests that the allocation of resources to achieve some goal may be followed by increased allocations when the goal is not attained. The explanation proposed for entrapment involves approach–avoidance conflicts in which, as time passes by, the desire to achieve a goal surpasses the desire to minimize cost–benefit ratios.

More recently, it has been demonstrated that the investment of any resource (e.g., time, effort, or money) in an activity directed at achieving some outcome may result in "irrational" sunk-cost effects, whereby the tendency to commit additional resources is positively influenced by the magnitude of prior investments (Arkes & Blumer, 1985; Garland, 1990; Garland & Newport, in press).

A number of researchers have suggested prospect theory (Kahneman & Tversky, 1979) as a viable explanation for these sunk-cost effects (Arkes & Blumer, 1985; Garland, 1990; Garland & Newport, in press; Northcraft & Neale, 1986; Whyte, 1986). According to prospect theory, decision outcomes are normally evaluated as gains and losses from some reference point. Furthermore, individuals are proposed to be influenced by a "certainty effect," in which probable outcomes are underweighted in comparison with certain outcomes. Because withdrawal from a course of action may lead to any sunk costs being viewed as a certain loss, people ought to become more reluctant to withdraw as sunk costs increase. Finally, prospect theory proposes a value (i.e., utility) function for gains and losses, which we have depicted in Figure 1.

To understand how this value function may contribute to sunk-cost effects, consider an individual, depicted at Point A, who has expended $X$ dollars on a prospect in the absence of any return. The individual is now faced with the decision of abandoning the prospect and realizing a disutility of $Y$ units or investing $X$ more dollars to continue with the prospect. The first alternative is riskless, whereas the second offers either a potential gain in utility of $Y$ units (should the entire investment be recovered and the individual wind up at Point B) or an additional loss of $Y' - Y$ units (should the individual fail to receive any return and wind up at Point C). The convex shape of the value function under loss assures that $Y' - Y$ will always be less than $Y$. Given an even chance of additional loss or complete recovery of the entire investment, the individual ought to prefer additional investment to withdrawal.

What the above analysis ignores are any specific relationships that might exist in a particular situation among sunk costs, negative feedback (i.e., the absence of returns), and the subjective probability of future returns. These relationships can vary widely across different decision contexts and types of decision tasks.

In games of pure chance, sunk costs mount with each loss,

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Correspondence concerning this article should be addressed to Howard Garland, Department of Business Administration, University of Delaware, Newark, Delaware 19716.

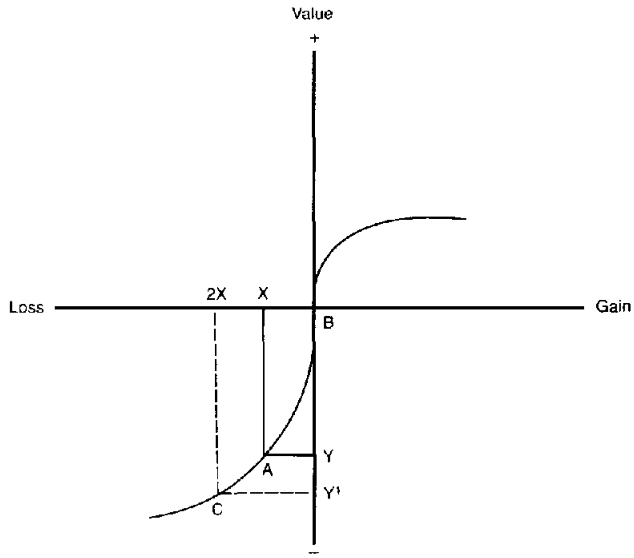


*Figure 1.* The proposed value function from prospect theory (Kahneman & Tversky, 1979).

but prior loss and future return are unrelated. Sunk-cost effects, as predicted from prospect theory, may indeed occur in these games. Furthermore, the common "gambler's fallacy," based on the erroneous belief that a series of losses makes a win more likely (Tversky & Kahneman, 1974), serves to strengthen sunk-cost effects in gambling situations.

In research and development (R&D) projects, long delays between investments and returns, coupled with the fact that increased expenditures usually bring one closer to project completion, may result in great reluctance to withdraw from projects as investments increase. Indeed, studies using R&D decision scenarios have often found strong sunk-cost effects (Arkes & Blumer, 1985; Garland, 1990; Garland & Newport, in press).

In other situations, failure to achieve a desired outcome after action (e.g., no return following some investment) may serve as negative feedback, causing lower expectations about future returns after similar actions (Kernan & Lord, 1989; Lord & Maher, 1990). Recently, Staw and Ross (1987) argued that when negative feedback suggests that future investment is not likely to result in positive returns, as it might when negative returns are experienced repeatedly (Staw & Fox, 1977), or when the cause of a negative return is perceived to be endogenous to the course of action itself (Staw & Ross, 1978), de-escalation or withdrawal from the course of action may be the most likely response.

In the present research, we focused on decision making in the context of petroleum-exploration ventures. Rose (1987), a professional petroleum geologist, described such ventures as follows:

> Mineral exploration can be defined as a series of investment decisions . . . Each decision should produce a progressively clearer determination of risk versus reward, and support timely management action concerning the inferred mineral deposit or accumulation. An idealistic definition of exploration might be a series of investment decisions made with decreasing uncertainty. (p. 1)

In one type of petroleum-exploration situation, the drilling of a dry well, the term *sunk cost* takes on literal meaning. Typically, some company, partnership, or individual has acquired a lease position with the intention of drilling a number of wells on the lease. On the basis of geophysical data, a decision is made to drill a well in a particular spot on the lease. If the well turns out to be a dry hole, a significant sunk cost (i.e., the cost of drilling the well) has been incurred. At the same time, the dry well provides feedback that may influence the decision maker's expectations of finding another profitable well on the lease.

After drilling one dry well, the decision maker must decide whether to drill another well or discontinue drilling on the lease. The interesting question here is how, if at all, this second decision will be influenced by the negative outcome from the earlier well. On the one hand, prospect theory might predict that the cost of the first well, in the absence of any return, will place the decision maker on the loss side of the value function, thereby increasing the likelihood of his or her drilling the next well. On the other hand, if the dry well decreases the perceived likelihood of subsequent discovery, the decision maker may be less willing to drill the next well. Assuming that the decision maker does not run out of funds, the question can be extended to how a second, third, and *n*th dry well will influence the decision to drill the next well on a lease, given that with each dry well, both sunk costs and negative feedback have increased.

It was not our purpose in this research to provide a definitive test of different theoretical models. At the present stage of theoretical development, we doubt that any empirical study of decision making in a moderately complex situation could provide such a test. Instead, we sought to examine the generalizability of sunk-cost effects on the escalation of commitment to ongoing projects among expert decision makers in a familiar context in which sunk costs are inextricably tied to clear negative feedback.

## Experiments 1 and 2

Subjects in these experiments were geologists involved in independent oil and gas exploration. A mail survey was used to conduct two different experiments simultaneously. Each respondent was presented with one of five oil-exploration scenarios, which had been randomized before the mailing. The scenarios were developed by Craig A. Sandefur and Anne C. Rogers, both experienced petroleum geologists, in conjunction with other professionals in the industry.

Four scenarios formed a between-subjects experiment (Experiment 1) with sunk costs manipulated by depicting a situation in which one to four dry wells had already been drilled, at a fixed cost per well, on a lease with a drilling budget that allowed for 5 wells. After reading a scenario, each geologist was asked to indicate both the likelihood of authorizing the funds to drill the next well and the perceived likelihood that the next well drilled would be productive.

The fifth scenario was a within-subjects experiment (Experiment 2) designed to better represent the dynamic nature of oil-exploration decisions. Geologists were first asked to indicate the likelihood that, after one dry well, they would authorize the funds to drill the next well. They then continued to respond in an evolving scenario to questions about the likelihood of authorizing funds for a third, fourth, and fifth (i.e., last) well, assuming that all preceding wells had been dry.

## *Method*

*Sample.* Independent petroleum geologists ($N = 481$) were selected from the computerized membership database of a geological society in a large southwestern city in the United States. Membership in the society is made up primarily of independent geologists and geologists who work for major corporations. We chose independent geologists because we believed they would have the widest range of exploration experiences. The survey was conducted in the spring of 1988. A total of 235 completed surveys were returned, producing a response rate of 49%. In Experiment 1 (between-subjects), the final sample size was 197, and in Experiment 2 (within-subjects), the final sample size was 38, $\chi^2(1) = 2.15$, *ns.*

*Survey procedure.* A personal cover letter and postage-paid return envelope were sent along with our experimental scenario to each individual surveyed. The cover letter stated that we had received the cooperation of the geological society in conducting research on decision making in the oil and gas industry. Respondents were assured of the confidentiality of their responses and thanked in advance for their cooperation. The fact that the survey asked for no demographic information served to both reinforce our promise of confidentiality and reduce the amount of time necessary for responding.

*Experiment 1.* As indicated earlier, Experiment 1 was a between-subjects design with four levels of sunk costs (one to four dry wells). All subjects received a two-page protocol. A cover page (identical in all conditions) asked respondents to assume that they were experiencing the situation depicted on the second page of the protocol and to respond as if they really did have to make a decision. The importance of actually placing themselves in the situation described was then reiterated.

The decision scenario was designed to portray, albeit in simplified form, a realistic petroleum drilling situation. All information presented was easily understandable to petroleum geologists. To examine the impact of dry wells on the decision to drill additional wells, all other things being equal, we deliberately excluded from our scenarios the typically rich geological and geophysical data that geologists receive when they drill a dry well. The actual scenario used in the one-dry-well condition was as follows:

> Your company has acquired a good sized lease position within a well known North American basin, the position was acquired at a cost of $135,000.
>
> The company has recently drilled a 50 bopd [barrels of oil per day] discovery well on the lease. The acreage position is such that a minimum of five more wells can be drilled. The drilling partnership provides a 1 million dollar budget for the five subsequent wells. The budgeted cost per well is $200,000 ($100,000 drilling cost; $100,000 completion cost). You have been given the final authority to authorize all expenditures on this project. The discovery well has proven out both your original exploration approach and associated geophysical data. However, the confirmation well was a $100,000 dry hole. Your total cost for this nonproducing well is, thus, $100,000.

Subjects in the two-, three- and four-dry-well conditions read the same scenario, except that it was specified that the confirmation well and the next one, two, or three wells had all been dry holes. In addition, it was specified that the total cost for these two, three, or four dry holes was $200,000, $300,000, or $400,000. By emphasizing the total cost of dry wells in each condition, we hoped to make sunk costs salient to all subjects.

A number of points should be made about how practicing petroleum geologists would interpret the facts presented to them in these scenarios. First, the positive information provided about the discovery well clearly implies that there is oil on the land. Second, it would be assumed that the geologist had made the specific choice as to the best location to drill all wells on the land. Third, the relatively low cost of the land, compared with the cost of drilling, is typical in the industry. Finally, it is typical to authorize both the cost of drilling and completion (i.e., actually extracting the oil should viable commercial quantities be found) for each well, even though the actual risk involved is only the dry-well cost, which in the present case is $100,000.

Immediately following the scenario were two questions. The first question asked subjects to indicate "on a scale from 0–100 how likely it is that if faced with this situation, you would authorize another $200,000 to drill the next [or third, fourth, last, depending on the subject's condition] well in the program?" Subjects responded by circling a point along a 100-point scale marked *definitely would not authorize* (1) and *definitely would authorize* (100) at the endpoints. The midpoint of the scale was marked *even chance.*

The second question asked, "Regardless of how you answered the previous question, what is your perception of the likelihood that the next well to be drilled on this prospect would produce 50 or more bopd?" The choice of 50 bopd was based on an expert judgment that, given the budget for this project and the price per barrel for oil at the time this research was conducted, this was about the smallest yield that would produce a reasonable return on investment. Subjects again responded along a 100-point scale marked *definitely would not produce 50 or more bopd* (1) and *definitely would produce 50 or more bopd* (100) at the endpoints and *even chance* at the midpoint.

*Experiment 2.* The protocol for this experiment included a cover page and four attached pages. The cover page was identical to that in the between-subjects experiment except that subjects were asked to assume that they were experiencing an evolving situation.

The next page presented the exact same scenario as that in the one-dry-hole between-subjects experiment. After reading the scenario, subjects were asked to respond to the same question about the likelihood of their authorizing another $200,000 to drill the next of the four remaining wells in the program. To avoid confusion in this more complicated research design, we did not ask subjects to indicate their perception of the likelihood that the next well would produce.

On the third page, subjects read the following:

> Assume that you had decided to drill the second well and it turned out to be another $100,000 dry hole. Your total expenditure for the two dry holes has been $200,000. On a scale from 0–100 how likely would you be to authorize another $200,000 to drill the next of the 3 remaining wells in the program?

On the fourth and fifth pages, subjects were asked to assume they had decided to drill the third and fourth wells, respectively. In each case, subjects were reminded of their total expenditure (i.e., $300,000 and $400,000, respectively) and asked to indicate the likelihood of their authorizing another $200,000 to drill the next well in the program. Repeated references to the total expenditures associated with the drilling of dry wells should have made sunk costs particularly salient to respondents in this within-subjects experiment.

## *Results*

Responses to the dependent measures in each of the dry-well conditions for both Experiments 1 and 2 are presented in Table 1.

Table 1
*Responses to Dependent Measures Across Four Dry-Well Conditions*

| Condition | Likelihood of authorizing funds | | Likelihood of well producing | |
|---|---|---|---|---|
| | $M$ | $SD$ | $M$ | $SD$ |
| Experiment 1 (between-subjects) | | | | |
| One dry well | $65.33_a$ | 35.52 | $51.02_a$ | 23.99 |
| Two dry wells | $30.76_b$ | 31.84 | $31.84_b$ | 18.42 |
| Three dry wells | $27.35_b$ | 29.72 | $28.85_b$ | 22.93 |
| Four dry wells | $13.87_c$ | 19.23 | $18.68_c$ | 16.79 |
| Experiment 2 (within-subjects) | | | | |
| One dry well | $66.21_a$ | 28.04 | | |
| Two dry wells | $31.82_b$ | 37.43 | | |
| Three dry wells | $8.92_c$ | 15.24 | | |
| Four dry wells | $1.74_d$ | 8.23 | | |

*Note.* Within columns, means with different subscripts are significantly different from one another, $p < .05$. Subjects in Experiment 2 were not asked to estimate the likelihood that the next well drilled would produce oil.

*Experiment 1.* First, we performed a multivariate analysis of variance on responses to both dependent measures across the four conditions of Experiment 1. The results of this analysis showed a highly significant effect of the number of dry holes that had been drilled, $F$ Wilks $(6, 384) = 13.13$, $p < .0001$.

Separate univariate tests on each dependent measure revealed a significant effect of number of dry wells on both the reported likelihood of authorizing the funds to drill the next well, $F(3, 193) = 26.67$, $p < .0001$, $\omega^2 = .28$, and the perceived likelihood that the next well drilled would be productive, $F(3, 193) = 20.82$, $p < .0001$, $\omega^2 = .23$. In addition, polynomial analyses revealed a highly significant linear trend on each measure, $F(1, 193) = 70.79$, $\omega^2 = .25$, and $57.17$, $\omega^2 = .22$, for the likelihood of authorizing and likelihood of producing measures, respectively, $p < .0001$.

As indicated in Table 1, the effect of number of dry wells on each dependent measure was clearly negative. The greater the number of dry holes, the less likely subjects were to authorize funds to drill the next well and the less likely they were to believe that the next well would produce.

Another interesting trend in these data is revealed in Table 1. Consider the difference between a subject's reported likelihood of authorizing funds for the next well and his or her perception of the likelihood that this well would be productive. Because both variables were measured with a 100-point subjective probability scale, a positive difference (i.e., higher probability of drilling than the perceived probability of finding oil) could be interpreted to reflect a particular type of risk seeking. Conversely, a negative difference (i.e., lower probability of drilling than the perceived probability of finding oil) might be interpreted as risk aversion. In the one-dry-well condition, the difference was positive (risk seeking); in the two- and three-dry-well conditions, there were no differences; and in the four-dry-well condition, the difference was negative (risk aversive). To assess the reliability of this apparent trend in the data, we performed a mixed-model analysis of variance (ANOVA) with number of dry wells treated as a between-subjects factor and type of dependent measure treated as a within-subjects factor.

The results of this analysis revealed a significant between-subjects main effect of the number of dry wells drilled, $F(3, 193) = 28.70$, $p < .0001$, $\omega^2 = .30$, no significant within-subjects effect for type of dependent measure, $F(1, 193) = 1.46$, and a significant interaction effect of these two factors on subjects' responses, $F(3, 193) = 7.21$, $p < .0001$, $\omega^2 = .09$. Although the significant interaction suggests that the trend noted in the preceding paragraph is statistically reliable, only in the one-dry-well condition was the difference between responses to the two dependent measures statistically significant, $F(1, 193) = 19.80$, $p < .0001$.

*Experiment 2.* A repeated-measures ANOVA (multivariate approach) revealed a highly significant effect of number of dry wells, $F$ Wilks $(3, 35) = 81.47$, $p < .0001$, $\omega^2 = .77$. As the number of dry holes increased, subjects were markedly less willing to authorize funds for the next well in the program.

Further inspection of Table 1 shows that the willingness to authorize funds to drill the next well after one or two dry wells was virtually identical across both the between- and within-subjects experiments. In Experiment 2, however, de-escalation of commitment to the drilling program after the third and fourth dry wells was far greater than in Experiment 1.

Subjects in Experiment 2 were actually a random subgroup of the sample used in Experiment 1. Thus, it is appropriate to make statistical comparisons across experiments at any level of the dry-wells variable. How a subject's willingness to commit resources to the drilling program was influenced by his or her previous decisions and by consistent negative feedback can be ascertained from such comparisons. The results of these comparisons were highly significant for three and four dry wells, $t(85) = 3.71$ and $t(89) = 4.05$, respectively, $p < .0001$.

In our final analysis of data from Experiment 2, we attempted to compare patterns of de-escalation after negative feedback among geologists who were more or less willing to drill following the first dry well in the program. To make this comparison, we divided geologists into two groups on the basis of the median reported likelihood of authorizing funds to drill the next well after one dry well had been drilled ($Mdn = 70$). We labeled geologists whose ratings were above the median as *enthusiastic* and those whose ratings were at or below the median as *unenthusiastic.* A graphic comparison of the relationship between number of dry wells drilled and reported likelihood of drilling the next well across these two groups is presented in Figure 2.

This figure shows that the two groups converge over time with repeated negative feedback. A 2 (enthusiastic vs. unenthusiastic) × 4 (number of dry wells) mixed-model ANOVA on these data revealed that, in addition to the two main effects of enthusiasm and number of dry wells, there was also a significant interaction effect, $F$ Wilks $(3, 34) = 19.63$, $p < .0001$, $\omega^2 = .09$.

## Discussion

The results of Experiments 1 and 2 suggest very clearly that, in their decisions to withdraw from or escalate their commitment to an ongoing project, these petroleum geologists were

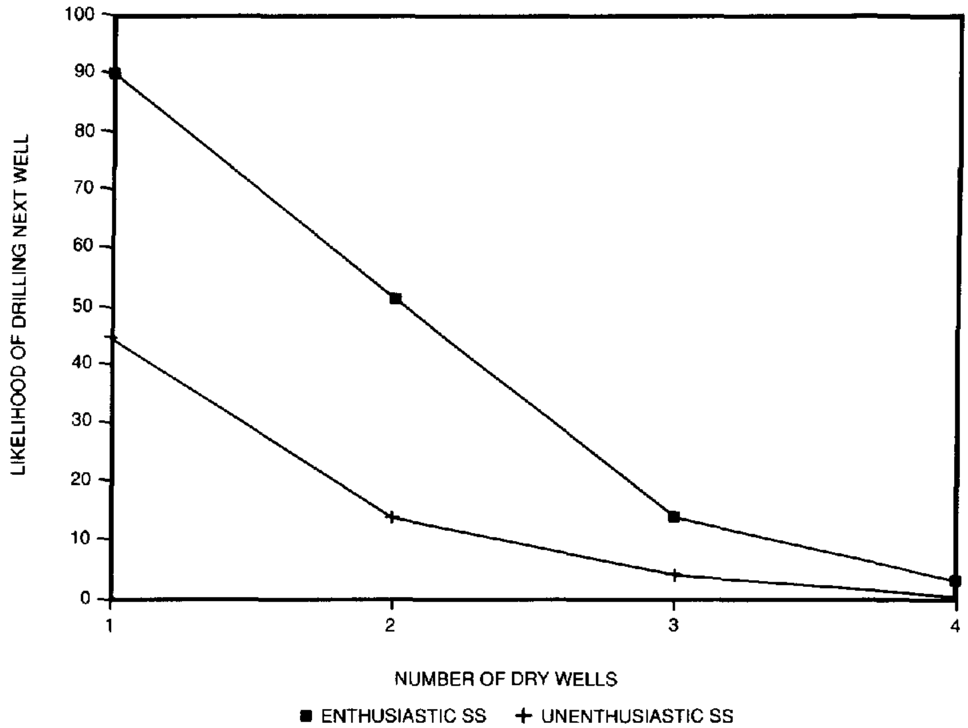


*Figure 2.* Relation of dry wells drilled to likelihood of authorizing funds for next well among enthusiastic and unenthusiastic subjects.

not subject to the kind of sunk-cost effects that have been observed in previous research studies (Arkes & Blumer, 1985; Garland & Newport, in press). In earlier work, higher sunk costs have been associated with decisions to escalate involvement in ongoing projects, but in this study we found a strong and opposite effect. As sunk costs increased, subjects were less willing to commit additional resources to a project.

The results of Experiment 2 (within-subjects) both support and extend the results of Experiment 1 (between-subjects). As geologists in Experiment 2 made repeated decisions, they displayed an even stronger tendency than did geologists in Experiment 1 to de-escalate commitment to the well-drilling program as the number of dry wells increased.

Of course, the fact that subjects in Experiment 2 made their decisions in rapid succession could certainly have accounted for the apparent rationality of these decisions. However, the rapidly evolving scenario used in this within-subjects experiment repeatedly emphasized the overall expenditure for all dry wells in the program, which increased with each trial. Given this, it would surely have been reasonable, at least according to prospect theory, for the geologists to have become more risk seeking over trials, as they increasingly framed their decision as a choice between losses (Kahneman & Tversky, 1979). Furthermore, the fact that de-escalation was as strong (actually stronger) for those who were initially enthusiastic about drilling as it was for those who were less committed to begin with suggests that self-justification (Staw, 1981) was not a major factor in our results.

One obvious difference between our experiments and earlier work in this area is that our subjects were all experts who were presented with a decision problem that is common in their line of work. As noted by Conlon and Parks (1987), most experimental studies of escalation have used university students who lack experience in the decision-making contexts that researchers present them with. Although we believe that the expertise of our subject sample may have contributed to the strength of our results, we do not feel that this accounts for the direction of the results. Instead, we suggest that these results can be best attributed to our deliberate development of a decision scenario in which, with each increment of sunk costs, there was a corresponding increment in unambiguous negative feedback. Furthermore, the negative feedback that varied along with sunk costs was apparently very relevant to our respondents' expectations of future outcomes (i.e., finding oil) from future similar actions (i.e., drilling another well).

## Experiment 3

As discussed in the preceding paragraph, two factors, either alone or in combination, may account for the discrepancy between our findings and earlier research on sunk-cost effects on decision making. First, our subjects were all petroleum geologists, trained in rational decision making in their field of expertise, whereas the subjects of most experimental research on sunk-cost effects and escalation phenomena have been university students. The difficulty of generalizing from student to expert populations has been well documented (Gordon, Slade, & Schmitt, 1986). Second, we deliberately developed a decision scenario in which sunk costs were directly related to unambiguous negative feedback, whereas in earlier studies scenarios were used in which negative feedback was either more ambiguous or less diagnostic. To gain some insight into how less expert individuals might respond to our experimental procedure, we repeated our between-subjects experiment with a sample of university business students.

## Method

*Subjects.* Undergraduate students ($N = 77$) enrolled in introductory management courses at the University of Delaware served as subjects. They participated as part of a class exercise on decision making.

*Procedure.* The students were randomly given one of the four experimental protocols that were used in our between-subjects experiment with geologists (Experiment 1). After reading the scenario, they were asked to report the likelihood that they would authorize the funds for the next well in the program. Because of their lack of expertise, students were not asked to indicate the likelihood that the next well would be productive.

## Results

Student responses under each of the dry-well conditions are presented in Table 2. As the number of dry wells increased, students tended to de-escalate commitment, but an ANOVA on these data revealed that this effect was not statistically significant, $F(3, 73) = 0.88$.

## Discussion

The results of this replication with university students suggest that it was probably a combination of both the decision problem and the decision makers that contributed to our strong findings in the first two experiments with geologists. On the one hand, even with the student sample, we did not find the kind of sunk-cost effects that have been observed in previous research. This suggests that such effects are not likely to be found in situations in which sunk costs and clear negative feedback covary over time. On the other hand, we did not find the dramatic de-escalation displayed by the geologists, suggesting that problem- and context-specific expertise can have a powerful effect on decision-making behavior.

# General Discussion

The results of our experiments suggest that the effects of negative information on decisions to escalate or withdraw from ongoing projects may be influenced by the degree to which that information is diagnostic of future returns. By focusing on the decisions of petroleum geologists to persist in an oil-exploration venture after the drilling of dry wells, we purposely chose a situation in which very clear sunk costs were positively correlated with unambiguous negative feedback.

Table 2
*Likelihood of Authorizing Funds to Drill the Next Well as Reported by University Student Subjects (Experiment 3)*

| Condition | *M* | *SD* |
|---|---|---|
| One dry well | 61.90 | 29.77 |
| Two dry wells | 59.00 | 22.10 |
| Three dry wells | 57.63 | 23.47 |
| Four dry wells | 49.47 | 23.45 |

As indicated earlier, this research was not designed to provide a test of different theoretical models of escalation and withdrawal. Nevertheless, our results do suggest that one must be careful in attempting to use any one decision model to understand the impact of single variables (e.g., sunk costs, negative feedback, etc.) on behavior across situations in which all things are far from equal.

What can be learned from these results is that, despite any tendencies respondents may have had to engage in self-justification (Staw, 1981), and despite a decision problem in which withdrawal was very likely to be framed as a loss (Kahneman & Tversky, 1979), the structure of the problem was such that respondents could not ignore the diagnostic value of repeated failures that mounted in direct proportion to sunk costs. Had we chosen to structure the problem differently, our results may have looked quite different. For example, it is possible that the greater the funds expended to drill a well to a certain depth, the greater the propensity to drill even deeper when no oil has been found.

In their recent review of behavior in escalation situations, Staw and Ross (1987) contrasted a prototype situation for withdrawal with one for escalation. They asserted that a major factor in the withdrawal prototype is that the "objective situation increasingly worsens over time, making it economically clear that persistence is more costly than withdrawal" (p. 69). Another factor that Staw and Ross associated with the withdrawal prototype is the existence of "social norms for experimentation and the acceptance of failure" (1987, p. 69). The first of these factors was certainly present in the dry-well scenario we presented to the petroleum geologists. The second seems endemic to the oil-exploration industry. Thus, in this research we seem to have identified at least one combination of an applied decision context and a problem in which increasing sunk costs are associated with increasing tendencies to withdraw from rather than escalate commitment to ongoing projects.

In a number of ways, the methodology utilized in this research seems to represent a step forward from earlier studies of sunk-cost and escalation effects; in those studies, more often than not, university students were asked to respond to hypothetical scenarios outside the realm of their experience. Nevertheless, we offer the following caveat about our methodology and results.

No matter how expert the respondent and how relevant the scenario, survey experiments cannot substitute for the study of actual decision making in field settings. Although it would be unlikely that one could manipulate sunk costs or feedback or both in most business settings, researchers should not abandon more descriptive field studies of actual decision behavior. The fact that our scenarios excluded the type of detailed data and social pressures usually present in oil-exploration ventures may have contributed to the overall level of rationality observed. The absence of these complicating factors in our research may have heightened the salience of negative feedback and reduced concerns about self-justification. It is possible that, had our geologists been involved in a real drilling project, their decisions would have been less rational and more susceptible to escalation effects.

We suggest that future research on sunk-cost effects should expand in a number of different directions. Although the escalation literature is filled with anecdotal examples of what look like sunk-cost effects, more descriptive field research and controlled experimental studies are needed to document the conditions under which such "irrational" effects are most and least likely to occur. There is also a definite need to combine the manipulation of theoretically important variables with richer methods of collecting respondent data. One promising method of data collection that has proven useful for gathering detailed information on risk taking in management decision making is the *risk in-basket* (MacCrimmon & Wehrung, 1984, 1985). Finally, researchers should continue to investigate practical techniques that have the potential to contribute to effective decision making by minimizing irrational sunk-cost effects and maximizing concern for future costs and benefits.

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