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A Meta-Analysis of the Sunk Cost Effect on Project Escalation

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ABSTRACT

Escalation is a serious management problem and sunk costs can promote escalation behavior. While many laboratory experiments have been conducted to examine the sunk cost effect on escalation, there has been no effort to examine these studies as a group in order to determine the effect size associated with the so-called "sunk cost effect." Using meta-analysis, we analyzed the results of 20 sunk cost experiments and found: (1) a large effect size associated with sunk costs, (2) variability of effect sizes across experiments that was larger than pure subject-level sampling error, and (3) stronger effects in experiments involving IT projects as opposed to non-IT projects. Implications of the results and future research directions are discussed.

INTRODUCTION

The amount of money already spent on a project (level of sunk cost), together with other factors, can bias managers' judgment, resulting in "escalation of commitment" behavior (Brockner 1992) in which failing projects are permitted to continue. Project escalation can absorb valuable resources without producing intended results. While escalation is a general phenomenon occurring with any type of project, software projects may be particularly susceptible to this problem (Keil, Mann, and Rai 2000).

Prior research has identified psychological as well as other factors that can promote escalation (Staw and Ross 1987). The sunk cost effect is a psychological factor that can promote escalation and refers to the notion that people have a "greater tendency to continue an endeavor once money, time and efforts have invested" (Arkes and Blumer 1985).

There are several possible explanations for the sunk cost effect. Chief among these is Prospect Theory which suggests that people will choose to engage in risk-seeking behavior when faced with a choice between losses. According to Prospect Theory, people will prefer to make additional investments (even when the payoff is uncertain) rather than terminating a project and "losing" all of the monies already spent.

In the context of software projects, the intangible nature of the product (Abdel-Hamid and Madnick, 1991) can make it difficult to estimate the amount of work completed. This difficulty manifests itself in the "90% complete syndrome"[1] which may promote the sunk cost effect by giving a false perception that most of the required money, time, and effort have already been expended.

To investigate the sunk cost effect, researchers have conducted many role-playing experiments in which sunk cost levels are manipulated to determine if they have an effect on decision-making (e.g., Garland 1990; Garland and Newport 1991). The results of previously published experiments on sunk cost and escalation do not provide information about the magnitude of the sunk cost effect. At this point, there is a need to step back and assess this stream of research, discover the consistencies and account for the variability.

In this study, we use meta-analysis to determine the mean effect size of sunk cost on project escalation and examine variability of effect sizes across experiments. We also examine whether the effect size of sunk cost effect on project escalation is different for IT vs. non-IT projects.

LITERATURE REVIEW

Experiment Studies on Sunk Cost Effect on Project Escalation

Arkes and Blumer (1985) conducted a series of 10 experiments, demonstrating that prior investments in an endeavor will motivate people to continue commitment, although rationally people should only consider incremental benefits and costs in decision making. Many researchers conducted similar experiments based on one of the Arkes and Blumer scenarios (Garland 1990; Whyte 1993; Heath 1995; Moon 2001). These experiments consistently showed that when facing negative information, subjects with a higher sunk cost level have a greater tendency to continue a project than subjects with a lower sunk cost level. Based on these experiments, escalation has been linked to the level of sunk cost.

Although project escalation is a general phenomenon, IT project escalation has received considerable attention since Keil and his colleagues began studying the phenomenon (Keil, Mixon et al. 1995). Survey data suggest that 30-40 percent of all IT projects involve some degree of project escalation (Keil, Mann, and Rai 2000). To study the role of sunk cost in software project escalation, Keil et al. (1995) conducted a series of lab experiments, in which sunk costs were manipulated at various levels, and subjects decided whether or not to continue an IT project facing negative prospects. This IT version of the sunk cost experiment was later replicated across cultures (Keil, Tan et al. 2000), with group decision makers (Boonthanom 2003), and under different de-escalation situations (Heng, Tan et al. 2003). These experiments demonstrated the sunk cost effect to be significant in IT project escalation.

Research Gaps

Many experimental studies have been conducted to investigate the sunk cost effect on project escalation. However, research that summarizes, integrates, and interprets this line of research is still lacking. First, previously published studies all take the approach of statistical significance testing, which only provides information about whether the sunk cost effect is significantly different from zero, but does not provide any information about the size of effect. Is the sunk cost effect a small or moderate effect, or is it a large effect that is really worth noting? Are the results consistent across different experiments? Such questions have not been answered by previous studies. Second, IT projects have been identified as a type of project that may be particularly prone to escalation. Whether the magnitude of the sunk cost effect is greater for IT vs. non-IT projects, however, has not been explored.

RESEARCH METHODOLOGY

Meta-Analysis Method

To investigate the above research questions, we conducted a meta-analysis. Meta-analysis is defined as "the analysis of analysis…the statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating findings" (Glass 1976). Meta-analysis researchers gather a sample or a population of research reports, read each research report, code the appropriate information about the research characteristics and quantitative findings, and analyze the data using special adaptations of conventional statistical techniques to investigate and describe the pattern of findings in the selected set of studies(Lipsey and Wilson 2001). Over the years, meta-analysis has become a legitimate statistical tool to integrate empirical research findings in many disciplines, such as medicine, education, and psychology (Hwang 1996).

Meta-analysts define a measurement that is "capable of representing the quantitative findings of a set of research studies in a standardized form that permits meaningful numerical comparison and analysis across studies"(Lipsey and Wilson 2001). This is known as the effect size. In meta-analysis involving experiments, the standardized mean difference between groups is commonly used to compute the effect size (Hunter and Schmidt 1990). The formula is:

$$ES_{sm} = \frac{\overline{X}_{G1} - \overline{X}_{G2}}{s_{pool}}.$$

ES_{sm} is effect size, $\overline{X}_{G1}$ is mean of the experiment group. $\overline{X}_{G2}$ is the mean of the control group. s_p is pooled standard deviation of the two groups.

The two primary functions of meta-analysis are combining and comparing studies (Cooper and Hedges 1994). Meta-analysis can be used to accumulate empirical results across independent studies and provide a more accurate representation of population characteristics. When effect sizes among studies vary beyond the subject-level sampling errors, moderator analysis can be conducted to find out whether a particular study characteristic causes the variability. Primary studies can be split into subgroups and findings in different group can be further tested.

Data Collection and Coding

A literature search was performed primarily on electronic sources (ABI/Inform, EBSCO Business Source Premier, and ScienceDirect), as well as several conference proceedings (ICIS, HICSS, AMCIS) using the keywords "sunk cost", "project continuation", and "project escalation". After obtaining a list of potentially relevant articles, we scanned the papers' abstracts and retained articles that satisfy the following criteria: (1) It is an experimental study of the sunk cost effect on escalation, (2) The article reports the statistics from which standardized mean differences between groups can be derived, (3) The decision task used in the experiment is a project continuation decision. Based on these criteria, 12 research articles were retained for subsequent analysis.

Some articles contain results from multiple experiments. For example, Keil, Tan et al. (2000) replicate the same experiment across three different countries. Since our unit of analysis is a single experiment, multiple experiments in the same study report are considered statistically independent as long as they use a different population (Hunter and Schmidt 1990). Thus, we ended up with 20 separate experiments in our sample.

These 20 experiments were coded for statistics that can derive effect sizes, study characteristics such as decision task type, and sunk cost level for both treatment and control groups. In experiments where sunk costs were manipulated at two levels (for example, 10% vs. 90%), the high sunk cost level group was considered to be the treatment group and the low sunk cost level group was considered to be the control group. In experiments where sunk costs were manipulated at more than two levels, the highest sunk cost group was selected as the experiment group and the lowest sunk cost group as the control group. In experiments that manipulate sunk cost level and completion level separately, the subgroups in which sunk cost level and completion level were proportionately controlled were used in this study in order to avoid potential confounding effects.

Table 1. Analysis Results

Step1: Calculate mean effect size and confidence interval

N	Mean ES	-95%CI	+95%CI	SE	Z	P
20	.89	.81	.97	.04	21.10	.00

Step 2: Homogeneity Analysis

Q	df	p
150.88	19	.00

Step 3: Moderator analysis on type of project in decision task

------ Analog ANOVA table (Homogeneity Q) -------

	Q	df	p
Between	7.22	1	.007
Within	143.66	18	.000
Total	150.88	19	.000

------- Q by Group -------

Group	Q	df	p
Non-IT	90.46	11	.00
IT	53.20	7	.00

------- Effect Size Results by Group -------

Group	Mean ES	SE	-95%CI	+95%CI	Z	P	N
Non-IT	.80	.05	.70	.91	15.26	.00	12
IT	1.04	.07	.90	1.18	14.82	.00	8

Data Analysis and Results

Three analysis steps were taken to answer the research questions. In the first step, mean effect size and confidence interval were calculated for the sunk cost effect. Second, a homogeneity test was performed to detect whether sunk cost effects were consistent across experiments. Third, the type of project involved (IT vs. non-IT) in the decision tasks was used as moderator to explain the variances across studies. The results are shown in Table 1.

Step 1: Calculating mean effect size and confidence interval: Since standardized mean difference effect size suffers from a slight upward bias when based on small samples (Cooper and Hedges 1994), each effect size was first corrected before further calculation. According to Hunt and Schmidt (1990), the best estimate of the population effect size is not the simple mean across studies, but a weighted average in which each effect size is weighted by the number of subjects in a single experiment. Using this method, we calculated the mean effect size and confidence interval for the sunk cost effect. The mean effect size is 0.89. The 95% confidence interval is 0.81-0.97. This estimate was based on fixed effects model, in which effect size observed in a study is assumed to estimate the corresponding population effect with random error that stems only from the chance factors associated with subject-level sampling error in that study (Hedges and Vevea 1998; Overton 1998).

Step 2: Testing for homogeneity of effect sizes: The objective of the homogeneity test of effect sizes is to determine whether the effect sizes come from the same population (Cooper and Hedges 1994). "If there is no real variation in population effect sizes, then the observed variance will be exactly equal to the variance due to sampling error" (Hunter and Schmidt 1990). In our study, a Chi square test was conducted and the Q statistic is significant at the 0.01 level. A significant Q rejects the assumption of homogeneity. This means that the variability across different experiments is larger than the subject-level sampling error, and thus systematic differences across experiments might cause the variations among effect sizes.

Step 3: Comparing sunk cost effect sizes for IT project and Non-IT project: When the effect sizes are found not to be homogeneous, meta-analysts can proceed with an examination of whether the substantive and methodological study characteristics moderate the effect sizes (Lipsey and Wilson 2001). In this study, we attempted to detect whether the results of the experiments involving IT projects were different from the results of the experiments involving non-IT projects, so effect sizes were partitioned into two groups according to the project context. A Chi square test was conducted to examine the between group effect size variance and within group effect size variance. We found that the between-group Q statistic was significant at the 0.01 level, showing that the project context significantly explained part of the variances. However, the within-group statistic is also highly significant, telling us that the variance within each group (IT vs. Non-IT projects) still remain heterogeneous. Mean effect sizes and 95% confidence intervals were calculated for each group. The mean effect size for the IT project group is 1.04, and the 95% confidence interval is 0.90-1.18. The mean effect size for non-IT project group is 0.80, and the 95% confidence interval is 0.70-0.91. A t-test revealed that the mean difference is significant at the 0.01 level.

DISCUSSION

A widely used convention for appraising the magnitude of effect sizes was established by Cohen (1988). Standard mean difference effect sizes are considered small if less than or equal to 0.20, medium if equal to 0.50, and large if 0.80. In our study, after ruling out subject-level sampling error, the mean effect size associated with the sunk cost effect is 0.89, which qualifies as large. Decision makers apparently have tremendous difficulty ignoring sunk cost when making project continuance decisions.

A test of the homogeneity of effect sizes showed that variability in results across experiments is beyond subject-level sampling error. The project context (IT or non-IT) can significantly explain a part of the variance, but the effect sizes remain heterogeneous within each group. Therefore, potentially other substantive or methodological study characteristics moderate the effect sizes.

Our moderator analysis results showed that the magnitude of the sunk cost effect is greater in experiments involving an IT project context than in experiments involving a non-IT project context. This finding is consistent with the claim that IT projects are particularly susceptible to escalation (Keil, Mann, and Rai 2000). The reasons why the magnitude of the sunk cost effect may be greater in IT project settings needs to be explored with further research. One potential explanation is that people are more optimistic about the prospect of IT projects than that of non-IT projects, and thus perceive a high likelihood of success even when faced with negative information.

CONCLUSION

While meta-analysis is a powerful technique for quantitatively integrating and interpreting prior research results, it is not without limitations. First, effects in published studies tend to be larger and insignificant findings tend to remain unpublished. Meta-analysis, which surveys primary studies, in turn has an upward bias, known as the "file drawer problem" (Smith 1980; Begg 1994). Second, moderator analysis in meta-analysis is susceptible to confounds. The significant difference observed between the two groups in terms of effect size needs to be interpreted with caution, as it may reflect other experimental differences that do not relate to the type of project.

In spite of the aforementioned limitations, this research represents the first attempt to synthesize, integrate, and interpret the research stream on the sunk cost effect and its influence on project escalation. The study contributes to existing knowledge in three ways. First, through meta-analysis of 20 experiments, we found that the sunk cost effect is large. Second, we tested the homogeneity of effect sizes, and found that the variability of the sunk cost effect is larger than subject-level sampling errors. Third, we found that the magnitude of the sunk cost effect is greater in experiments involving IT project contexts than in experiments involving non-IT project contexts. Future research can be undertaken in two directions. First, because of the strong magnitude and heterogeneity of effect sizes for the sunk cost effect, we need more primary studies that investigate potential moderators of sunk cost effects. Second, the reasons why IT projects are particular susceptible to sunk cost effects need to be investigated, and tactics for reducing the influence of sunk costs on decision-making need to be explored.

While more research is needed, prior studies have suggested that the sunk cost effect can be reduced by: (1) avoiding negative framing, (2) encouraging people to focus on alternatives and consider opportunity costs, (3) making negative feedback unambiguous, and (4) increasing the decision-maker's accountability (Garland, Sandefur, and Rogers, 1990; Northcraft and Neale, 1986; Keil et al., 1995; Simonson and Nye, 1992).

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ENDNOTES

[1] This syndrome refers to the tendency for estimates of work completed to increase steadily until a plateau of 90% is reached. Software projects tend to be "90% complete" for half the entire duration (Brooks, 1975).

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