IGI PUBLISHING
701 E. Chocolate Avenue, Suite 200, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.igi-pub.com

ITJ3742

This paper appears in the publication, **Information Resources Management Journal**, Volume 20, Issue 3
edited by **Mehdi Khosrow-Pour © 2007, IGI Global**

A Meta-Analysis Comparing the Sunk Cost Effect for IT and Non-IT Projects

Jijie Wang, Georgia State University, USA

Mark Keil, Georgia State University, USA

ABSTRACT

Escalation is a serious management problem, and sunk costs are believed to be a key factor in promoting escalation behavior. While many laboratory experiments have been conducted to examine the effect of sunk costs 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, and (2) stronger effects in experiments involving information technology (IT) projects as opposed to non-IT projects. Implications of the results and future research directions are discussed.

Keywords: IS project control; IS project failures

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 the intended results. While escalation is a general phenomenon occurring with any type of project, software projects may be particularly susceptible to this problem (Keil et al., 2000a).

Prior research has identified psychological as well as other factors that can promote escalation (Staw & 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 a project once money, time, and effort have been invested (Arkes & Blumer, 1985).

There are several possible explanations for the sunk cost effect. Chief among these is prospect theory (Brockner, 1992; Kahneman & Tversky, 1979), 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 & 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 & Newport, 1991). These published experiments suggest that there is broad agreement that sunk cost increases commitment to projects. However, there are a couple of unanswered questions. First, while prior studies have conducted statistical significance testing, they do not provide much information about the magnitude of the sunk cost effect. Second, although there have been claims that IT projects are more prone to the sunk cost effect, there have been no prior studies to determine if the magnitude of the sunk cost effect is larger in an IT project context than it is in a non-IT project context.

Meta-analysis, a literature review method using a quantitative approach, is very good at assessing a stream of research, discovering the consistencies, and accounting for the variability. Therefore, in this study, we conduct a 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 the sunk cost effect on project escalation is different for IT vs. non-IT project contexts.

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 have conducted similar experiments based on one of the Arkes and Blumer scenarios (Garland, 1990; Heath, 1995; Moon, 2001; Whyte, 1993). 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 et al., 1995a). Survey data suggest that 30 to 40 percent of all IT projects involve some degree of project escalation (Keil et al., 2000a). To study the role of sunk cost in software project escalation, Keil et al. (1995a) 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 et al., 2000b), with group decision makers (Boonthanom, 2003) and under different de-escalation situations (Heng 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 effect size. 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, but this has not been demonstrated empirically. Therefore, we do not know if the magnitude of the sunk cost effect is truly greater for IT, as opposed to non-IT, projects. In this study, we seek to fill these research gaps.

RESEARCH METHODOLOGY

Meta-Analysis Method

To investigate the above research gaps, 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 involves gathering a sample or a population of research reports, reading each research report, coding the appropriate information about the research characteristics and quantitative findings, and analyzing the data using special adaptations of conventional statistical techniques to investigate and describe the pattern of findings in the selected set of studies (Lipsey & 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-analysis uses effect size as a measure 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 & Wilson, 2001). In meta-analysis involving experiments, the standardized mean difference between groups is commonly used to compute the effect size (Hunter & Schmidt, 1990). The formula used to compute the effect size depends upon the statistics reported in the study. When descriptive statistics such as the mean and standard deviation are available, the formula used to calculate effect size is:

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

where ES_{sm} is effect size, $\overline{X}G1$ is mean of the treatment group, $XG2$ is the mean of the control group, and s_{pool} is the pooled standard deviation of the two groups.

When descriptive statistics such as mean and standard deviations are not available, other reported statistics can be used to derive an estimated effect size. For example, when independent t-test (t) and sample sizes (n) for each group are available, the formula used to calculate effect size is:

$$ES_{sm} = t\sqrt{\frac{n1 + n2}{n1n2}}$$

(Lipsey & Wilson, 2001), where t is the t-test statistic, and n1 and n2 are the sample sizes for the treatment and control group, respectively.

In experiments that use dichotomized dependent measures (e.g., continue the project vs. abandon the project), the proportion of subjects in each group that decided to continue the project is often reported. For example, 80% of the subjects in the treatment group decided to continue the project, while only 30% of the subjects in the control group decided to do so. In such situations, effect size can be estimated by performing an arcsine transformation using the following formula:

$$ES_{sm} = ar\sin e(p_{G1}) - \arcsin e(p_{G2})$$

(Lipsey & Wilson, 2001), where P_{G1} and P_{G2} are the proportions of subjects in the treatment and control group that decided to continue the project.

The two primary functions of meta-analysis are combining and comparing studies (Cooper & 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 groups 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, and 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 was an experimental study of the sunk cost effect on escalation; (2) The article reported the statistics from which standardized mean differences between groups could be derived; (3) The decision task used in the experiment was a project continuation decision. Based on these criteria, 12 research articles were retained for subsequent analysis. These articles were published from 1985 to 2003. Because IT researchers did not begin to embrace this area until 1995, much of the work was from the psychology and organizational behavior areas. The nature of the 12 articles is summarized in Table A of the appendix.

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

Because the effect size in our study was based on the standardized mean difference between groups, for each experiment we needed to identify one group as the treatment and another as the control group. In the experiments in our sample, the level of sunk cost was manipulated as an independent variable and was used to create multiple treatment levels. In experiments in which sunk costs were manipulated at two levels (for example, 10% vs. 90%), the high sunk cost level group was considered the treatment group and the low sunk cost level group was considered the control group. In experiments in which 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. For example, in some experiments sunk cost were manipulated at 4 levels: 15%, 40%, 60%, and 90%. When such situations arose in our meta-analysis, the sub-group with 90% sunk cost level was considered the treatment group and the sub-group with 10% sunk cost level was considered the control group.

In some experiments, researchers have attempted to independently manipulate sunk cost (e.g., percent of budget already spent) and completion (e.g., percent of project already completed). The problem is that in trying to tease apart the influence of these two factors, confounds can be introduced. For example, when a subject is told that a project is 90% complete, but only 10% of the budgeted funds have been expended, this generates positive feedback (for the project is nearly done, even though only a small fraction of the budget has been spent). To control for this type of confound, we limited ourselves to treatment conditions in which sunk cost and percent completion were jointly manipulated.

In total, 20 experiments were included in our meta-analysis and were coded for statistics that would be used to derive effect sizes, study characteristics such as decision task type, and sunk cost level for both treatment and control groups. The statistics used to derive effect sizes and the effect sizes of the 20 experiments are shown in Table 1. Table B in the appendix lists the formula used to calculate the effect sizes.

Data Analysis and Results

Three analysis steps were taken to address the research gaps identified earlier. First, the mean effect size and confidence interval were calculated for the sunk cost effect. Second, a homogeneity test was performed to determine whether sunk cost effects were consistent across

Table 1. Data sources and effect sizes

#	Sunk Cost Level in Experiment Group	Sunk Cost Level in Control Group	Context	Effect Size Source	Experiment Group Mean	Experiment Group S.D.	Experiment Group Size	Control Group Mean	Control Group S.D.	Control Group Size	Spool	Other ES Sources	ES	ES'
Arkes and Blumer (1985)	9 million and 90% of budgeted funds	0	non-IT	proportion			48			60	N/A	41 out of 48 subjects in treatment group escalated, while 10 out of 60 subjects in control group escalated	0.8504	0.2021
	9 million and 90% of budgeted funds	0	non-IT	From t value			76			82	N/A	t(156)=2.02, p<0.05	0.3201	0.1602
	9 million and 90% of budgeted funds	0	non-IT	proportion			58			37	N/A	37 out of 58 subjects in treatment group escalated, while 2 out of 37 subjects in control group escalated	0.6326	0.2153
Garland (1990)	9 million	1 million	non-IT	mean and std	76.50	29.36	64	29.00	29.36	64	29.36		1.6178	1.6081
	9 million	1 million	non-IT	mean and std	69.50	29.03	75	36.00	36.00	75	29.36	N/A	1.1540	1.1481
Whyte (1993)	Sunk cost is present (Individual decision makers)	Sunk cost is absent	non-IT	proportion			50			52	N/A		0.4381	0.4348
Conlon and Garland (1993)	9 million/90% complete	1 million/10% complete	non-IT	mean and std	74.57	28.17	35	56.97	28.17	35	28.17	66% of subjects in treatment group escalated, while only 29% in control group escalated	0.6248	0.6178
	9 million/90% complete	1 million/10% complete	non-IT	mean and std	58.03	24.31	53	40.36	24.31	53	24.31	N/A	0.7269	0.7216
Keil et al. (1995a)	90% of budgeted funds	15% of budgeted funds	IT	mean and std	74.87	25.53	39.00	48.21	31.69	39.00	28.77		0.9270	0.9178

Table 1. continued

Keil, Truex, and Mixon (1995b)	90% of budgeted funds	15% of budgeted funds	IT	mean and std	40.00	25.00	31	40.00	25.00	31	25.00		0.0000	0.0000
	90% of budgeted funds	15% of budgeted funds	IT	mean and std	57.50	25.00	31	40.00	25.00	31	25.00		0.7000	0.6912
Garland and Conlon (1998)	8 million/80% complete	2 million/20% complete	non-IT	mean and std	76.00	22.79	24	66.27	22.79	26	22.79		0.4269	0.4206
Arkes and Hutzel (2000)	Sunk cost is present.	Sunk cost is absent.	non-IT	proportion			37			36	N/A	64% of subjects in treatment group escalated, while only 19% in control group escalated	0.5101	0.5047
	Sunk cost is present.	Sunk cost is absent	non-IT	proportion			109			121	N/A	58% of subjects in treatment group escalated, while only 37% in control group escalated	0.2352	0.2344
Keil et al. (2000)	90% of budgeted fund	15% of budgeted fund	IT	mean and std	62.08	22.78	47	44.04	26.76	46	24.95		0.7230	0.7172
	90% of budgeted funds	15% of budgeted fund	IT	mean and std	73.94	22.07	30	37.19	21.14	30	26.20		1.4025	1.3857
	90% of budgeted funds	15% of budgeted fund	IT	mean and std	80.88	14.30	58	57.59	20.55	58	21.73		1.0719	1.0648
Moon (2001)	9 million(90% complete)	1million (10% complete)	non-IT	mean and std	80.73	31.00	170	32.94	31.00	170	31.00		1.5416	1.5382
Heng et al. (2003)	75% of budgeted funds	25% of budgeted funds	IT	mean and std	80.50	14.32	180	57.10	14.32	180	14.32		1.6341	1.6307
Boonthanom (2003)	75% of budgeted funds (75% complete)	25% of budgeted funds (25% complete)	IT	mean and std	60.82	24.10	119	53.90	24.10	116	24.10		0.5423	0.5388

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 2.

- **Step 1:** Calculating the mean effect size and confidence interval

Since standardized mean difference effect size suffers from a slight upward bias when based on small samples (Cooper & Hedges, 1994), each effect size was first corrected before further calculation. The unbiased effect size estimate is

$$ES'_{sm} = \left[1 - \frac{3}{4N-9}\right] ES_{sm}$$

(ES'_{sm} is the corrected effect size, while ES_{sm} is the original effect size, N is the overall sample size). According to Hunter 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 was 0.89. The 95% confidence interval was 0.81-0.97.

- **Step 2:** Testing for homogeneity of effect sizes

Homogeneity analysis of the effect sizes answers one important question: Do the various effect sizes that are averaged into a mean value all come from the same population (Hedges, 1982b; Rosental & Rubin, 1982)? In a homogeneous distribution, the dispersion of the effect sizes around their mean is no greater than that expected from sampling error alone (the sampling error associated with the subject sample upon which the individual effect sizes are based). If the statistical test rejects the null hypothesis of homogeneity, it indicates that variability of the effect sizes is larger than that expected from sampling error alone and thus further analysis is needed to investigate whether there are other systematic factors (e.g., study characteristics)

Table 2. 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

that can explain the heterogeneity among effect sizes (Lipsey & Wilson, 2001).

The homogeneity test is based on the Q statistic, and it was calculated using the following the formula:

$$Q = \sum w_i (ES_i - \overline{ES})^2,$$

where ES_i is the individual effect size for i-1 to k (the number of effect sizes), $\overline{ES}$ is the weighted mean effect size over the k effect sizes, and w_i is the individual weight for ES_i. Q is distributed as a chi-square with k-1 degrees of freedom, where k is the number of effect sizes (Hedges & Olkin, 1985; Lipsey & Wilson, 2001). A statistically significant Q rejects the null hypothesis of homogeneity and thus indicates a heterogeneous distribution.

In our study, a chi-square test was conducted, and the Q statistic was found to be 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.

The preceding discussion assumes a 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 & Vevea, 1998; Overton, 1998). An alternative is a random effects model, which assumes that there are essentially random differences between studies associated with study-level variations such as study procedures and settings in addition to subject-level sampling error. We used a fixed effects model because the experiments in our analysis followed similar research procedures to study the escalation of commitment.

- **Step 3:** Comparing sunk cost effect sizes for IT projects and Non-IT projects

When the effect sizes are found not to be homogeneous, meta-analysis can proceed with an examination of whether the substantive and methodological study characteristics moderate the effect sizes (Lipsey & 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 variance. However, the within-group statistic was also highly significant, indicating that the variance within each group (IT vs. non-IT projects) still remains heterogeneous. Mean effect sizes and 95% confidence intervals were calculated for each group. The mean effect size for the IT project group was 1.04, and the 95% confidence interval was 0.90-1.18. The mean effect size for non-IT project group was 0.80, and the 95% confidence interval is 0.70-0.91. A t-test revealed that the mean difference was significant at the 0.01 level.

DISCUSSION AND IMPLICATIONS

A widely used convention for appraising the magnitude of effect sizes was established by Cohen (Cohen, 1977; 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 was 0.89, which qualifies as large. While prior research had already documented the existence of the sunk cost effect, in this study we provide evidence of the strength of the sunk cost effect across a range of experiments that have sought to investigate the phenomenon. The large affect size suggests that decision makers have tremendous difficulty ignoring sunk cost when making project continuance decisions. The implication of such a large effect size is that managers cannot afford to ignore the sunk cost effect and its influence on escalation behavior.

A test of the homogeneity of effect sizes showed that variability in results across experiments goes beyond what one would expect based on subject-level sampling error alone. The project context (IT or non-IT) significantly explains 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. While it has previously been claimed that IT projects may be particularly susceptible to escalation (Keil et al., 2000a; Newman and Sabherwal, 1996), there has been no empirical evidence to substantiate this claim. The fact that we observed a difference in effect size between experiments that involved IT project scenarios vs. experiments that involved non-IT project scenarios is intriguing. The implication of this finding is that IT projects may indeed be more susceptible to the sunk cost effect. If this is the case, further research is needed to determine why the magnitude of the sunk cost effect may be greater in IT project settings. 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. While additional research is clearly warranted on this point, in the meantime, IT managers should be particularly sensitive to the impact that sunk costs can have on escalation behavior.

LIMITATIONS

While meta-analysis is a powerful technique for quantitatively integrating and interpreting prior research results, it is not without limitations. One of the limitations of the experimental studies upon which our meta-analysis is based is their external validity, meaning to what extent the results can be generalized to organizational settings. Because the meta-analysis is based on the results from primary studies, it still carries this limitation. Second, 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" (Begg 1994; Smith, 1980). Third, 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. Finally, the sample size of 20 used in this particular meta-analysis was not large. Nonetheless, we were able to have sufficient power to detect significance in our homogeneity test.

CONCLUSION

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 two respects. First, through meta-analysis of 20 experiments, we calculated the sunk cost effect size and found that the sunk cost effect is large. Second, we found that the variability of the sunk cost effect is larger than one would expect based on subject-level sampling errors, and part of the variability can be attributed to the context of the experimental scenarios. Specifically, we found that the magnitude of the sunk cost effect was greater in experiments involving IT project contexts than in experiments involving non-IT project contexts.

Our meta-analysis pointed out future research directions in this research stream. 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 particularly 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, & Rogers, 1990; Keil et al., 1995b; Northcraft & Neale, 1986; Simonson & Nye, 1992).

REFERENCES

Abdel-Hamid, T., & Madnick, S. E. (1991). *Software project dynamics: An integrated approach*. Englewood Cliffs, NJ: Prentice Hall.

Arkes, H. R., & Blumer, C. (1985). The psychology of sunk cost. *Organizational Behavior and Human Decision Processes 35*, 124-140.*

Arkes, H. R., & Hutzel, L. (2000). The role of probability of success estimates in the sunk cost effect. *Journal of Behavioral Decision Making 13*(3), 295-306.*

Begg, C. B. (1994). Publication bias. In H. Cooper and L. V. Hedges, *The handbook of research synthesis* (pp. 399-409). New York: Russell Sage Foundation.

Boonthanom, R. (2003). Information technology project escalation: Effects of decision unit and guidance. In *Proceedings of 24th International Conference on Information Systems*.*

Brockner, J. (1992). The escalation of commitment to a failing course of action. *Academy of Management Review 17*(1), 39-61.

Brooks, F. P. (1975). *The mythical man-month: Essays on software engineering*. Reading, MA: Addison-Wesley

Cohen, J. (1977). *Statistical power analysis for the behavioral sciences*. New York: Academic Press.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.)*. Hillsdale, NJ: Erlbaum.

Conlon, D. E., & Garland, H. (1993). The role of project completion information in resource allocation decisions. *Academy of Management Journal 38*(2), 402-413.*

Cooper, H. & Hedges, L. V. (1994). The handbook of research synthesis. New York: Russell Sage Foundation.

Garland, H. (1990). Throwing good money after bad: The effect of sunk costs on the decision to escalate commitment to an ongoing project. *Journal of Applied Psychology 75*(6), 728-731.*

Garland, H. & Conlon, D. E. (1998). Too close to quit: The role of project completion in maintaining commitment. *Journal of Applied Psychology 28*(22), 2025-2048.*

Garland, H., Sandefur, C.A., & Rogers, A.C. (1990) De-escalation of commitment in oil exploration: When sunk costs and negative feedback coincide, *Journal of Applied Psychology 75*(6), 721-727.

Garland, H., & Newport, S. (1991). Effects of absolute and relative sunk costs on the decision to persist with a course of action. *Organizational Behavior and Human Decision Processes 48,* 55-69.

Glass, G. V. (1976). Primary, secondary, secondary, and metaanlaysis. *Educational Researcher 5*, 3-8.

Heath, C. (1995). Escalation and de-escalation of commitment in response to sunk costs: The role of budgeting in mental accounting. *Organizational Behavior and Human Decision Processes 62*(1), 38-54.

Hedges, L. V. (1982). Estimating effect size from a series of independent experiment. *Psychological Bulletin, 92*, 490-499

Hedges, L. V., & Olkin, I. (1985), *Statistical methods for meta-analysis*. Orlando, FL: Academic Press

Hedges, L. V., & Vevea, J. L. (1998). Fixed- and random-effects models in meta-analysis. *Psychological Methods 3*, 486-504.

Heng, C. S., Tan, B. C. Y., & Wei, KK. (2003). De-escalation of commitment in software projects: Who matters? What matters? *Information and*

Management 41, 99-110.*

Hunter, J. E., & Schmidt, F. L. (1990). *Methods of meta-analysis, correcting error and bias in research findings*. Sage Publications.

Hwang, M. I. (1996). The use of meta-analysis in MIS research: Promises and problems. *The Data Base for Advances in Information Systems 27*(3), 35-48.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decisions under risk. *Econometrica, 47*, 263-291

Keil, M., Mann, J., & Rai, A. (2000a). Why software projects escalate: An empirical analysis and test of four theoretical models. *MIS Quarterly 24*(4), 631-664.

Keil, M., Mixon, R., Saarinen, T., & Tuunainen, V. (1995a). Understanding runaway information technology projects. *Journal of Management Information Systems 11*(3), 65-85.*

Keil, M., Truex, D., & Mixon, R. (1995b). The effects of sunk cost and project completion on information technology project escalation. *IEEE Transactions on Engineering Management, 24*(4), 372-381.*

Keil, M., Tan, B. C. Y., et al. (2000b). A cross-cultural study on escalation of commitment behavior in software projects. *MIS Quarterly 24*(2), 299-325.*

Lipsey, M. W., & Wilson, D. B. (2001). *Practical meta-analysis*. Sage Publications.

Moon, H. (2001). looking forward and looking back: Integrating completion and sunk cost effects within an escalation-of-commitment progress decision. *Journal of Applied Psychology 86*(1), 104-113.*

Newman, M., & Sabherwal, R. (1996). Determinants of commitment to information systems development: A longitudinal investigation. *MIS Quarterly 20*(1), 23-54.

Northcraft, G.B., & Neale, M.A. (1986) Opportunity costs and the framing of resource allocation decisions. *Organizational Behavior and Human Decision Processes* 37(3). 348-356.

Overton, R. C. (1998). A comparison of fixed-effects and mexed (random-effects) models for meta-analysis tests of moderator variable effects. *Psychological Methods 3*, 354-379.

Rosenthal, R., &Rubin, D. B. (1982) Comparing effect sizes of independent studies, *Psychological Bulletin, 92*, 500-504

Simonson, I., & Nye, P. (1992) The effect of accountability on susceptibility to decision errors. *Organizational Behavior and Human Decision Processes (51)*, 416-446.

Smith, M. L. (1980). Publication bias and meta-analysis. *Evaluation in Education 4*, 22-24.

Staw, B. M., & Ross, J. (1987). Behavior in escalation situations: antecedents, prototypes, and solutions. In B. M. Staw and L. L. Cummings, *Research in organizational behavior* (pp. 39-78). Greenwich, CT: JAI Press Inc.

Whyte, G. (1993). Escalating commitment in individual and group decision making: A prospect theory approach. *Organizational Behavior and Human Decision Processes 54*, 430-455.*

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).

* The references with * are articles used as primary data sources in the meta-analysis.

APPENDIX A.

Table A. Summary of the research used in meta-analysis

Paper	Research Focus	Relevant Hypotheses	Sample size	Experimental Design	Reported Results	Conclusion
Arkes and Blumer (1985)	Explore the impact of sunk cost on individuals' decision making Explore the impact of sunk cost on individuals' decision making	No explicit hypotheses	108	Sunk cost was manipulated as either 90% or 0. Subjects made project continuance decision and provided yes/no answers.	chi-square(1, N=108)=50.6, p<0.001	People have difficulty ignoring sunk cost when making decisions.
			158	Sunk cost was manipulated as either 90% or 0. Subjects made project continuance decision and provided yes/no answers. Subjects were also asked to provide the probability of the project's success.	t(156)=2.02, p<0.05	Subjects in sunk cost situation have an inflated estimate of the project success likelihood
		No explicit hypotheses	95	Sunk cost was manipulated as either 90% or 0. Subjects made project continuance decision and provided yes/no answers.	chi-square (1, N=95)=29.5, p<0.01	Sunk cost effect found to be powerful even when one's general opinion is solicited.
Garland (1990)	Study the relationship between the level of the sunk cost and the decision to continue a project.	No explicit hypotheses.	127	Subjects specified the probability that they would invest all the remaining budgeted funds into a failing research and development (R&D) project. Sunk cost and project completion level were jointly manipulated at 4 levels: $1 million (10%), 3m (30%), 5m (50%), 70m (70%), and 9m (90%).	F(4,122)=12.2, p<.0001	Subjects' willingness to continue to invest on a threatened project was positively and linearly related to the proportion of the budget already expended.
			150	Subjects specified the probability that they would invest the next $1 million (of the $10 million budgeted funds) into a failing R&D project. The sunk cost and project completion level were jointly manipulated at 4 levels: 1m (10%), 3m (30%), 5m (50%), 70m (70%), and 9m (90%).	F(4,1145)=6.67, p<.0001	Subjects' willingness to authorize additional resources for a threatened R&D project was positively and linearly related to the proportion of the budget that had already been expended.
Whyte (1993)	Study the sunk cost effect on escalation in individual and group decision making	Escalation will occur for both individuals and groups regardless of personal responsibility.	325	The experimental design involved six project continuance decision making scenarios, three decision frames, and two performing units. Decision frames were manipulated by the presence or absence of sunk cost. Performance units included individual or group decision makers. Subjects were asked to make decisions whether to continue investment on the projects.	The decision frame effect is F(2, 59)=122.6; p<0.001	Escalation occurred at both individual and group levels, and group decision making amplifies this effect.

Table A. continued

Conlon and Garland (1993)	Explore whether sunk cost or project completion level leads to escalation	No explicit hypothesis.	554	Sunk cost was manipulated at 1, 5, and 9 million. Project completion levels were manipulated at 10%, 50%, and 90%. Competitor's performance was manipulated at two levels—superior and inferior.	Sunk cost effect is F (3, 550) =20.48, p<0.001. The project completion effect is F(3,550)=3.94, p<.01	Both sunk cost and project completion had significant main effects on subjects' willingness to allocate all the money remaining in the budget to complete the project
			226	The experiment was a 2 by 2 by 2 between subjects factorial design with 2 levels of each of the following: sunk cost (1 million or 9 million), project completion (10% or 90%), knowledge about the budget (known or unknown), and responsibility for initial investment decision (low or high).	Sunk cost effect is insignificant. The project completion effect is significant. F(1, 209), p<.001	The completion effect may dominate the sunk cost effect in terms of promoting escalation behavior.
Keil, et al. (1995)	Test the impact of sunk cost and completion level within the context of IT project	H1: Willingness to continue with an IT project will be positively correlated with the level of sunk cost and degree of project completion level. H2: Regardless of sunk cost and completion, subjects will exhibit less willingness to continue with a prior course of action given the presence of an alternative course of action that appears equally attractive. H3: In the presence of both sunk cost and completion information, subjects who escalate their commitment to a project will more frequently justify their action on the basis of completion, or proximity to goal, as opposed to sunk cost, or the amount of resources already expended.	322	Sunk cost and completion level were jointly manipulated at 4 levels. An alternative project was manipulated as either present or absent.	Sunk cost/completion was significant at the 0.001 level. The effect of an alternative project was significant at the 0.001 level.	People have difficulty ignoring sunk cost when making project continuation decisions with or without an alternative project. Content analysis shows that sunk cost is the most frequently mentioned factor among people who decide to continue the project. Presence of an alternative project decreases people's willingness to continue a failing project.

Table A. continued

Keil et al. (1995)	An initial exploration of sunk costs in an IT project context	No explicit hypotheses	124	The experiment used a scenario of an in-house software development project. Sunk cost level was manipulated as 15%, 40%, 65%, and 90%	The results did not reveal the expected upward sloping sunk cost effect; instead, the results showed a horizontal line with a mean response of approximately 40% to the "willingness to continue" measure	Sunk cost effect was not significant in IT project context.
	Explore the sunk cost effect when projects go over budget	No explicit hypotheses	247	8 levels of sunk cost were manipulated, from 15% to 610%	There appears to be an upward sloping sunk cost effect from 15% to 90% sunk cost level. There was some de-escalation when sunk cost moved from 90% of budget to 10% over budget, but there did not appear to be any further de-escalation as the sunk cost moved from 100% of budget to higher levels.	Subjects did not de-escalate their commitment in the face of extreme budget overruns.
Garland and Conlon (1998)	Replicate Conlon and Garland (1993) with bank managers as subjects	H1: As project completion increases, subjects' willingness to continue investment in the project will increase	106	The experiment was 2 (sunk cost level) by 2 (project completion level) factorial between subjects design. Sunk cost was manipulated at 2 million or 8 million and completion level was manipulated at 20% or 80%	Completion effect is significant $F(1, 102)=11.63$, $p<0.001$. Neither sunk cost effect nor interaction is significant.	The completion effect may dominate the sunk cost effect in promoting escalation behavior.
Arkes and Hutzel (2000)	Study and the relationship between sunk cost, probability of success(p), and decision to invest. Is p a cause of sunk cost effect, a consequence of the effect or both?	No explicit hypothesis	148	The experimental design is a 2 by 2 design involving sunk cost (90% and no sunk cost) and probability of success (34% or unspecified).	Log-linear analysis shows the sunk cost effect is significant.	The presence of sunk cost significantly increased willingness to invest approximately equally whether or not the project success probability was specified.
		No explicit hypothesis	241	The experimental design was a 2 by 2 design involving sunk cost (10% or 90%) and timing of project success estimate provided by subject (before or after the investment decision).	The sunk cost effect is $F(1, 222)=4.61$. The effect of the timing of the project success probability on escalation is $F(1, 222)=6.43$, $p<0.02$. The sunk cost effect on success rate estimation is $F(1, 222)=4.61$	When the project success probability estimation followed the investment decision, it was significantly higher than when it preceded the investment decision.

Table A. continued

Keil et al. (2000)	Conduct cross-cultural study to examine the impact of sunk cost together with the risk propensity and risk perception of decision makers on their escalation of commitment behaviors	H 2: In all cultures, risk perception will have a significant inverse effect on willingness to continue a project. H 4: In all cultures, level of sunk cost will have a significant inverse effect on risk perception. H4a: The inverse relationship between level of sunk cost and risk perception will be stronger in cultures lower on uncertainty avoidance. H5: In all cultures, level of sunk cost will have a significant direct effect on willingness to continue a project.	185	Subjects were from Finland. In the first part, subjects read an experimental scenario in which sunk cost are manipulated at one of 4 levels (15%, 40%, 60%, 90%) and then indicate the probability they are willing to continue the project. In the second part, subjects complete a questionnaire to provide risk propensity and risk perception information.	The analysis is done using PLS, which uses a jackknifing technique to obtain T values. The relationship between sunk cost and willingness to continue a project was 0.15(T=3.01)*. The relationship between sunk cost level and risk perception was -0.16(T=-1.39). The relationship between risk perception and willingness to continue a project was -0.67(T=-9.04)*	The effect of the level of sunk cost on willingness to continue a project is direct and not mediated by risk perception.
			121	Same as above, but subjects were from the Netherlands.	The relationship between sunk cost and willingness to continue a project was 0.51(T=5.73)*. The relationship between sunk cost level and risk perception was -0.05(T=-0.07). The relationship between risk perception and willingness to continue a project was -0.43(T=-4.19)*	
			230	Same as above, but subjects were from Singapore.	The relationship between sunk cost and willingness to continue a project was 0.37(T=5.12)*. The relationship between sunk cost level and risk perception was -0.10(T=-0.86). The relationship between risk perception and willingness to continue a project was -0.46(T=-6.52)*	

Table A. continued

Moon (2001)	Investigate the main effects of sunk cost and completion level and their interaction effect.	H1: As the level of sunk costs increases, a decision maker will be significantly more willing to invest further into a progress-related project. H1b: The sunk-cost effect on a participant's propensity to continue investment into a project will be curvilinear in nature and shaped similarly to a marginal utility model. H2: As the level of completion increases, a decision maker will be significantly more willing to invest further into a progress-related project. H3a. Sunk cost will be more strongly related to commitment than completion under low-completion conditions but less strongly related to commitment than completion under high completion conditions. H3b. Sunk costs will not be related to commitment under low completions, but sunk costs will be related to commitment under high-completion conditions.	340	2 by 4 factorial design. Completion was manipulated at two levels and sunk cost was manipulated at four levels.	Sunk cost main effect was t (1,338)=2.26, $P<.05$, R square is 0.01. Completion main effect was significant. The interaction between sunk cost and completion was significant. T(5, 334)=2.00, $P<0.05$, R square=0.01	Sunk cost effects were present only within situations that were near completion. The shape of sunk cost effects has a curvilinear component.

Table A. continued

Heng et al. (2003)	Investigate the impact of individuals (superior and peers) and approach (shoulder blame and provide assurance) on de-escalation under varying conditions of sunk cost	H1: When sunk cost is low, willingness to terminate software projects with poor prospects (DoC) will be highest with support strategy (superiors provide assurance), followed by the shelter strategy (superiors shoulder blame), and finally no strategy. H2: When sunk cost is high, the willingness to terminate project will be the same with support strategy, shelter strategy, and no strategy. H3. When sunk cost is low, DoC will be highest with the sharing strategy, followed by sympathy strategy and no strategy. H4: When sunk cost is high, DoC will be the same with sharing strategy, the sympathy strategy and no strategy.	360	3 by 2 by 2 design involving: De-escalation approach (shoulder blame, provide assurance, do nothing), individual (superiors, peers), and sunk cost (low, high)	Sunk cost effect was significant at 0.01 level for entire group, for subgroups involving superiors, and for subgroups involving peers.	Under conditions of low sunk cost, several de-escalation strategies are effective. However, under conditions of high sunk cost, these strategies do not appear to facilitate de-escalation.
Boonthanom (2003)	This study investigates escalation of commitment in IT project development. An experiment is conducted to examine the impact of sunk cost, percentage of project completion, de-escalation strategy, and decision unit on the escalation behavior.	H1: Individuals will exhibit more escalation behavior given (a) high level of sunk cost and (b) high percentage of project completion. H2: Individuals will exhibit a relatively equal level of escalation behavior given either: (a) high sunk cost and low percentage of project completion or (b) low sunk cost and high percentage of project completion. H6a: On average, individuals without decisional guidance will exhibit more escalation behavior than individuals receiving decisional guidance.	235	A two-phase 2X2X2X2 lab experiment examining sunk cost (25%, 75%), completion level (25%, 75%), de-escalation strategy (present or absent), and decision unit (individual, group)	For both individuals and groups. The interaction effect between sunk cost level and completion level was significant (p-value=0.007). For individuals, sunk cost effect was only significant when completion level was high. For groups, the main project completion level effect was significant.	For individual escalation behavior, sunk cost effect was evident solely under the high project completion group.

Table B. Formula to calculate effect sizes (adapted from Lipsey & Wilson, 2001)

Formula	Data needed and definition of terms
Derive effect size from mean and standard deviation $ES_{sm} = \frac{\overline{X}_{G1} - \overline{X}_{G2}}{s_{pool}}$ $s_{pool} = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_1 - 1)s_1^2}{n1 + n2 - 2}}$	Means ($\overline{X}G1$, $\overline{X}G2$), standard deviation ($s1$,$s2$), and sample sizes ($n1$, $n2$)
Derive effect size from proportions $ES_{sm} = ar\sin e(p_{G1}) - \arcsin e(p_{G2})$	Arcsine transformation of the proportion (p) in each group. % of people in each group who makes escalation decision(p_{G2}, p_{G2})
Derive effect size from t test $ES_{sm} = t\sqrt{\frac{n1 + n2}{n1n2}}$	Independent t-test (t) and sample sizes ($n1$, $n2$) for each group

Jijie Wang is a PhD candidate in the Department of Computer Information Systems (CIS) at Georgia State University. Her research interests include the impact of IT on organizations, and IT project management. Her work has been presented in IRMA International Conference and Americas Conference on Information Systems, and published in Encyclopedia of E-Commerce, E-Government and Mobile Commerce. *She earned her bachelor's degree from Peking University, China, and her master's degree from Georgia State University.*

Mark Keil is a board of advisors professor of computer information systems (CIS) in the J. Mack Robinson College of Business at Georgia State University. His research focuses on software project management, with emphasis on understanding and preventing software project escalation. His research is also aimed at providing better tools for assessing software project risk and removing barriers to software use. Keil's research has been published in MIS Quarterly, Sloan Management Review, Communications of the ACM, Journal of Management Information Systems, IEEE Transactions on Engineering Management, Decision Support Systems*, and many other journals. He earned his bachelor's degree from Princeton University, his master's degree from MIT's Sloan School of Management, and his doctorate in management information systems from the Harvard Business School.*