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Understanding the Sunk Cost Effect: An Experimental Approach

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I. Introduction

The focus of this research is to examine the relevance of sunk costs in decision making. A "sunk" cost is an unrecoverable monetary or time commitment made to an endeavor. For example, the $16.95 a patron pays to enter the Bellagio (Las Vegas) Hotel's dinner buffet represents a sunk cost, since (in theory) none of the $16.95 can be recovered, even if the patron leaves without eating (to, say, collect on a million-dollar keno ticket). In contrast, the purchase of a $25 share of Circus-Circus stock is not sunk; the share can be resold at a later date, so at least part of the original $25 expenditure can be recovered. The prevailing economic paradigm suggests that, in general, rational consumers and producers will ignore sunk costs when making decisions.[1] Instead, optimal decision making is said to be made "on the margin", that is with consideration of only incremental costs (and benefits). Agents will (or, normatively, should) pursue those actions for which the marginal benefit is greater than or equal to the marginal cost.

Prior research has suggested that agents may consider sunk costs when making decisions. This *sunk cost effect* represents one of several anomalies that, taken together, pose a direct challenge to current standard economic theory as a positive description of decision making.[2] For example, in a two-agent, two-period model with incomplete contracting and uncertainty, Hackett (1993) challenges the prediction from standard economic theory that the division of second period surplus will be independent of the size of the first period (sunk) transaction specific investment. In addition to the striking predictive implications, gaining a better normative understanding of why some agents may in fact consider sunk costs could yield useful insights for refining and improving economic choice models.[3] Kahneman and Tversky (1979) have already developed an alternative model of decision-making, referred to as prospect theory, that was largely

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[1] Parayre (1995) notes and demonstrates circumstances under which "honoring" sunk costs is consistent with standard utility maximization.

[2] For an interesting review, see Dawes (1998), or Rabin (1998).

[3] Larrick, Nisbett, and Morgan (1993) argue that individuals whose decisions are consistent with standard economic theory are more successful, suggesting (from this sample) that as a normative matter sunk costs should be ignored.

motivated by the various anomalies associated with the standard expected utility economic choice model.

Two general approaches have emerged for examining the relevance of sunk costs in decision-making: surveys (associated primarily with what Thaler (1987) has labeled "behavioral decision research") and experiments (used more frequently in economic research). Economists have been slow to embrace the results derived from sunk cost surveys. In part, this reluctance is driven by a concern that the absence of real consequences following survey responses makes those choices unreliable signals of how agents might truly behave.

Explicitly or implicitly, surveys and experiments on sunk costs necessarily share (at least) three common elements: (i) the sunk cost, (ii) an initial endowment (or budget), and (iii) the marginal cost and benefit of escalation (i.e. continuing with the sunk cost activity). The relevance of sunk costs to decision making is most directly examined by varying (i) while holding (ii) and (iii) constant. However, given (i), variations in (ii) and (iii) may also affect decision-making, so it is possible that sunk cost effects found in some research may actually be driven by implicit or explicit variation in these other decision-making factors, as opposed to the presence of sunk costs *per se*.

Garland and Newport (1991) provide survey evidence that suggests that the sunk cost effect is positively related to the *relative* magnitude of the sunk cost (roughly, the sunk cost as a percentage of the endowment). Garland (1990) provides supporting survey evidence of the importance of relative (as opposed to the absolute value of) sunk costs. In a similar vein, within an experimental framework Meyer (1993) finds that the sunk cost effect becomes more pronounced as the size of the sunk cost increases. Phillips, Battalio, and Kogut (1991) also find this type of behavior in some of their experimental subjects.

With respect to (iii), surveys and experiments generally have a fixed and well-specified amount of additional funds that subjects can invest in either a sunk cost project (where some funds have already been committed) or an alternative. The quantity and quality of information provided about expected returns to the sunk cost and alternative projects varies dramatically, which may significantly affect the likelihood of observing sunk cost effects since this information provides (at least part of) the *frame* within which

decision are made. Northcraft and Neale (p. 354) argue that increasing the "salience" of the opportunity costs of escalation should reduce the "decision bias arising from aversion to certain loss". Similarly, Phillips, Battalio, and Kogut (pp. 112-113) argue that the more transparent the frame (i.e. the more clearly benefits and costs are conveyed in a problem), the more likely it is that agents will make "the 'correct' decision" (i.e. choose in a way that is consistent with standard economic theory). Tan and Yates (p. 315) argue that more and better information about the specific benefits and costs of continuing a project may reduce the sunk cost effect.

Using survey data, Northcraft and Neale (1986) present evidence that when the cost of continuing an activity is made more explicit, the sunk cost effect is less likely to be observed than when the cost of continuing the activity remains more implicit. Also using survey data, Tan and Yates (1995) find a significant reduction in the sunk cost effect when very explicit estimates of the costs and benefits of continuing the sunk cost activity are provided.[4] In contrast, Devine and O'Clock (1995) also use survey data and fail to find a significantly lower likelihood of honoring sunk costs when opportunity costs are made more explicit.[5]

It follows that the observed sunk cost effect may also be related to subjects' ability to process the information provided in experiments and surveys. Related to this idea, subjects aware of the normative prescription to ignore sunk costs may be more likely to do so (Larrick, Nisbett, and Morgan (1993)).[6] This understanding may be learned through a process of trial and error, or picked up from prior study (for example, in Economics or Accounting courses that tend to specifically discuss sunk costs). Phillips, Battalio, and Kogut (1991) argue that subjects may in fact learn to ignore sunk

[4] No information is provided about (potential) alternative uses of funds however.

[5] The difficulty in drawing many strong conclusions about the importance of information is also due in part to a lack of consistency in experimental designs. For example, in Arkes and Blumer (1985, experiment #3), 85% of respondents commit marginal funds to a sunk cost project knowing only that a competing firm has developed a potentially better product; no expected return estimates are provided for either continuation or any alternatives. In Northcraft and Neale (1986), the existence of alternative uses for funds is made more obvious, but rather than a dichotomous escalation decision, subjects respond on a 7-point scale about the attractiveness of continuing with a sunk cost project. As opportunity costs are made increasingly explicit, subjects rank the option of continuing with the project more negatively, but it is difficult to compare this result to Arkes and Blumer's "85%" figure.

[6] Northcraft and Neale (1986) suggest it would be interesting to consider the difference in sunk cost survey responses between "amateurs and experts" because "natural selection" and/or learning might be expected to make "experts" more likely to consider the appropriate benefits and costs.

costs. Larrick, Morgan and Nisbett (1990) show that subjects trained in the sunk cost rule are less likely to apply it outside of the laboratory. In contrast, Arkes and Blumer (1985) find that Economics majors are just as likely to display the sunk cost effect as students without prior exposure to the concept. Tan and Yates (1995) find that Accounting majors are less likely to exhibit the sunk cost effect in a production, but not in a consumption scenario.[7] Tan and Yates also speculate that Accounting students may be less likely to exhibit a sunk cost effect in the production case because of a greater concern for being held accountable for their choice in this context (given their curriculum, it would be difficult for an Accounting student to publicly defend the decision to honor a sunk cost).

This raises the interesting possibility that individuals may in fact make different choices using the same information set. As implied above, a number of explanations for the sunk cost effect are related to the idea of face-saving, or self-justification (see for example Staw and Ross (1987)). That is, a person making an initial sunk expenditure develops a personal stake in the outcome of the project, since perceptions about the decision maker's character and judgment may be linked to the project's ultimate fate. As a result, sunk cost effects may be related to the degree of personal attachment to the original decision; the person committing the initial funds to a project may be more likely to continue it than would be a third party.[8] Staw (1976) finds a positive relationship between continuing with a project and the level of personal responsibility for the associated sunk expenditure. Similarly, Arkes and Blumer (1985) find a more powerful sunk cost effect when subjects respond as the "company president" as opposed to a third-party observer.

The goal here is to bridge the gaps in the existing research on sunk costs. We include within an experimental economic framework the aspects that the literature in both Economics and Psychology conjecture are important to the sunk cost effect. We presently have two major dimensions to the project. The first looks at how explicitly

[7] The authors suggest that the difference might be due to the fact that the sunk cost problems encountered in a standard Accounting curriculum are likely to look much more like their survey's production example than consumption example.

[8] Alternative theories may lead to the same prediction. For example, if honoring sunk costs represents an effort to not appear wasteful, waste aversion may be much stronger for the person making the initial sunk cost decision (Arkes and Blumer (1985)).

stating different investment alternatives may affect the sunk cost effect. That is, subjects will be given several investment options which might include abandoning a current either entirely or for a different option, or sticking with their original choice where they have already sunk funds. The other dimension explores the roll of information in the sunk cost effect. Do subjects exhibit the sunk cost effect more often if information about investments is more opaque?

Section II develops the general experimental design. It also details the parameters and predictions for these particular experiments. Experimental results are reported in Section III. A discussion of the possible insights from these results is found in Section IV. Finally Section V suggests some conclusions from these experiments and outlines the direction of future research.

II. Experimental Design and Parameters

Consider a situation where firm has the opportunity to invest in a new R&D project. They must pay some amount of money and then see how the project turns out. On one hand it might all go well and everyone is happy, as the project is profitable. However, it is also possible, as is often the case, that things do not go as planed: Markets for the good might not exist, competitors may find a way to do it fast, cheaper, better, and so on. In this case the firm has a number of options. They may continue on their investment path with new expectations as to its possible outcome; they may abandon the project in favor of another; or they my abandon it and do nothing. It is this scenario that is the motivation for these experiments.

To reflect this framework, the experimental design is based upon a number of rounds, each of which is broken down into two time periods. In the first period the individual is informed that there exists an investment opportunity for which they must pay a fee S. This opportunity is known as Investment A and has two possible outcomes. With known probability ρ the good outcome (A_1) will occur. This is a positive pay off; as if the investment has turned out well. They also know that on the other hand with known probability $1-\rho$ something bad might happen. This is equivalent to the firm receiving bad news about the investment.

Subjects are asked to choose between paying the investment fee of S or declining the offer. If the subjects choose not to invest in A they keep their money and moves to the next round. If they choose to invest in A the uncertainly is resolved. If A_1 is realized the subject is paid and moves to the next round. If A_1 does not obtains the subject moves to period 2.

The subjects are told in the instructions, before the experiment begins that if they move to Period 2 they will face a number of options, two of which are consistent throughout the entire experimental session. One of these options will be to abandon the investment with no loss (save the sunk cost). Thus, the subjects know explicitly in Period 1 that regardless of what other investment opportunities exist in Period 2, that 0 bounds their downside risk. This 0 pay off is unambiguous and thus can be used by subjects to form a minimum value for the initial investment. So a subject will choose to invest in A in Period one if

$$\rho(A_1) + (1-\rho)(0) \geq 0 \qquad (1)$$

A second option is always to pay another fee of S_A and continue on with Investment A. Subjects are told that if they choose to pay the fee and continue in Investment A that it is possible that with probability σ, that the relatively high pay off of A_g will obtain. However it is possible with probablity1-σ, a lower pay off A_b will be the final outcome. It is also possible that a third option might be available. This would be a new investment. This third choice entails subjects abandoning Investment A all together and, for a fee of S_B, buy into Investment B which has a probability γ of paying B_g and 1-γ of paying B_b where $B_g > B_b$.

Thus, assuming prefect information and foresight, the subject's expected pay off in any round can be given by:

$$P = \left[\rho(A_1) + (1-\rho) \left[\max \begin{Bmatrix} \sigma(A_g) + (1-\sigma)(A_b) - S_A \\ \gamma(B_g) + (1-\gamma)(B_b) - S_B \\ 0 \end{Bmatrix} \right] \right] - S \qquad (2)$$

Given this, it is only rational for a subject to invest the project initially if equation (1) is true. Further, if A_1 does not obtain it is rational to continue only if,

$$\max \begin{vmatrix} \sigma(A_g) + (1-\sigma)(A_b) - S_A \\ \gamma(B_g) = (1-\gamma)(A_b) - S_b \end{vmatrix} \geq 0 \qquad (3)$$

As noted much of the research done in this area has assumed that to continue in investment A has a lower pay off then any other alternative. This means that the if subjects' alternatives are to continue with A or abandon it must be true that

$$\sigma(A_g) + (1-\sigma)(A_b) - S_A < 0\,, \qquad (4)$$

and that in the presence of any other investment alternatives

$$\sigma(A_g) + (1-\sigma)(A_b) - S_A < \gamma(B_g) + (1-\gamma)(B_b) - S_B\,. \qquad (5)$$

Thus, we can suggest that the sunk cost effect is observed when subjects choose Investment A in Period 2. That is, if a subject selects to stay with investment A when it is *not* the option that is expected to maximize payoffs in the second round this is a manifestation of the sunk cost effect.

The parameters for these experiments are contained in Table 1. The parameters were developed so that the conditions in equations (1), (4) and (5) held with strict inequality. The parameters are broken down into 4 sets each focusing on a different aspect of the sunk cost problem. All the sets have the same period 1 parameters which are contained in column 1 – 4. The first column contains the round one sunk cost S which for all rounds is 4. The parameters are broken down into 4 sets that attempt to test the hypotheses. The probability that the good outcome will occur in period 1 (ρ) is 0.5, and so with a good outcome of 10, and a bounded low outcome of 0, the expected value for period 1 is 5. Thus, it is always a dominant strategy to invest in period 1.

In the first set, the period 2 decision is between stopping and foregoing the initial sunk cost, or continuing on. If subjects continue they must pay an additional 2 (S_1). If they choose to continue, there is a high payoff (A_g) with a low associated probability (σ), and a high probability of no pay off. There is no alternative investment in this set. As is seen in column 14, the expected value of investing in period 2 is less then the sunk cost; subjects should not invest. In fact, across all sets the expected pay off from continuing to invest in period 2 is less than the investment cost. So it is never in a subjects best interest to continue to invest if they move into period 2.

Set II introduces an alternative investment in period 2, but keeps the expected value the same as set I. Again, in all cases, the low outcome either from continuing, or changing to investment B is 0 so as to avoid issues of loss aversion.[9] Set II parameters were also designed so that the variance across the expected period 2 payoffs was the same. Thus we can ask, "Holding expected payoff and variance constant, what is the effect of adding a second alternative to the mix?"

Set III withdraws the alternative investment, so that subjects either pay to continue with the one investment project, or stop. As can be seen in column 6, the good outcome in period 2 is now relatively very high, but it's associated probability (σ) is low, thus making further investment "irrational." What does change in Set III is the variance across the three rounds. As noted above, it has been suggested that the more obvious an investment strategy the more likely it is to be undertaken. In this case, a lower variance means clearer expected pay off in the second round. So as we move through the three rounds of this set, we would expect that the sunk cost effect might increase as the variance changes.

Also, in Set III the price of period 2 investment is dropped. This is done to begin to investigate the issue of whether it is the magnitude of price in the second investment affects the level of investment; will more people buy into an investment if it is cheaper (all else constant). This comparison is captured when we compare the last round of Set II with the first session of Set I.

[9] There is still an issue of the small probability of the preferred outcome which may help to enhance the sunk cost effect.

Set IV takes the natural step from Set III and raises the period 2 investment cost. While the parameters selected triple the period 2 expected value, it is still not rational to continue. Further it can be seen that like the last period in Set III, the variance in the last period in Set IV is the same as the last in Set III, and those in sets I and II. Again we are able to test the consistency of behavior across similar variance.

In any set, the information given to the subject was only the investment costs for a given period, the possible outcomes, and their associated probabilities. Thus, as discussed below, there is a rich series of hypotheses that can be examined using these parameters.

III. Results

Unfortunately, at the time of this writing, there are no results to share, either preliminary, or otherwise.

IV. Discussion

V. Conclusions and Future Research

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Table 1
Experimental Parameters

Set I: Basic (No alternative)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
S	**A_1**	**ρ**	**EV 1***	**S_1**	**A_g**	**σ**	**A_b**	**1-σ**	**B_g**	**γ**	**B_b**	**1-γ**	**EV 2**	**VAR**
4	10	0.5	5	2	20	0.08	0	0.92					1.6	14.72
4	10	0.5	5	2	10	0.16	0	0.84					1.6	6.72
4	10	0.5	5	2	6	0.267	0	0.733					1.6	3.5228
Set II: Increase options while holding EV and VAR constant														
4	10	0.5	5	2	40	0.0273	0	0.888	6	0.085	0	.915	1.6	14.723
4	10	0.5	5	2	30	0.0516	0	0.9484	6	0.009	0	.991	1.6	14.739
4	10	0.5	5	2	30	0.0512	0	0.9424	10	0.006	0	.994	1.6	14.72
4	10	0.5	5	2	72.1	0.00791	20	0.0269	19.53	0.025	0	0.975	1.6	14.723
4	10	0.5	5	2	53.4	0.015	33.235	0.015	6	0.05	0	0.95	1.6	14.658
Set III: Reduce Period 2 Investment Fee from Set II														
4	10	0.5	5	1	10	0.08	0	0.92					0.8	3.68
4	10	0.5	5	1	20	0.04	0	0.96					0.8	7.68
4	10	0.5	5	1	37.6	0.02128	0	0.9787					0.8	14.72
Set IV: Increase Period 2 Investment Fee From Set II														
4	10	0.5	5	4	40	0.08	0	0.92					3.2	58.88
4	10	0.5	5	4	20	0.16	0	0.96					3.2	27.494
4	10	0.5	5	4	12.4	0.25805	0	0.7419					3.2	14.72

*Based on worst outcome being abandonment (0)

Appendix

Instructions for Economics Experiment

General Instructions

This is an experiment in the economics of decision making. The instructions are simple and if you follow them carefully and make good decisions you will earn money that will be paid to you in cash.

In this experiment you will be presented with a number of different investment opportunities. Each will present various outcomes in terms of your earnings that will be determined by random draw. Attached to these instructions you will find a record sheet which will allow you to track your investment earnings through the course of the experiment. **You are not to reveal this information to anyone.** It is your own private information.

The currency in this market is francs. Each franc is worth 20 cents ($0.20) to you at the end of the experiment.

VI. Specific Instructions

This experiment is divided into a number of rounds each of which will have 2 periods. At the beginning of each period you will be given an allocation of francs. At the same time you will receive a Period 1 investment decision sheet. Before you make any choice you will be given information about an investment. You will be told about the two possible outcomes, how likely each is, and what the investment fee might be.

- The **investment fee** is the number of francs you must pay up front to be part of the investment. Once paid these francs are not refundable regardless of any subsequent decisions you might make.
- **Outcome A** is a franc earning on that investment that will occur with some announced probability.
- **Outcome B** is will automatically move you to Period 2.

So, for example, after you have received your allocation of francs you might be told that there is an investment opportunity for which you must pay 10 francs investment fee to get in on. If you pay the fee you have a 50% chance of getting the Outcome A which pays 100 francs, and a 50% chance of getting the Outcome B that will move you to Period 2.

Circle on your Period 1 decision sheet either **YES** to indicate that you want to participate in the investment opportunity or **NO** to indicate you do not.

If you decide to circle **NO** and not participate in the investment you are done for the Round. You will keep your endowment and be asked to wait patiently until the start of the next round.

If you choose to participate in the investment the proctor will come around to each subject individually and determine the outcome, either A or B. A random number generator is used, and the results will be reported to you at that time.

If Outcome A occurs you will receive the amount of announced earnings and will be asked to wait patiently for the next round. So in the example you would receive 100 and wait until the next round. If Outcome B is realized you will move to Period Two

If you move to Period 2 you will again be given a series of options which will be announced publicly at the time. In each round the first option will **always** be simply to abandon the investment and move to the next round. That is, you can decide to stop and wait for the next round. In this case you will **not** receive any earnings for the Round.

A second option will **always** be to continue with the investment. You will be told about a potential high and low earnings and the probability of each. So, for example, you might be told that if you decided to continue you would have a 25% chance of earning 400 francs, and a 75% chance of earning –100 francs. Depending on the Round, there may be another, non-refundable investment fee to continue investing. In other words if you choose the second option in Period 2 you might have to pay an additional 80 francs as an investment fee.

In some cases there will be a third option which is a different investment opportunity. As with the second option you will be told a high earnings, a low earnings, and the probability that each will occur. There may also be a non-refundable investment fee. It may or may not be different from the investment fee in Period 1 or the second option in Period 2.

Therefore if you move into Period 2 you will have the option to stop with a 0 earnings or continuing to invest in one or another possible options. After the options are reviewed, you will be given a Period 2 decision sheet and asked to indicate which option you choose. You must select one and only one option.

Once all the decision sheets have been filled out and franc balances adjusted for any period 2 investment fee, the proctor will come around and determine your Period 2 outcome. If you choose to stop this will be noted. However if you choose to continue an investment you will be told if you received the high or low earnings.

Once everyone has recorded their earnings for the period and the round everyone will move to the next round where you will be given a new endowment of francs a new Period 1 decision sheet, and a new Period 1 investment opportunity will be introduced.

You should note that at the end of each round your holdings of francs will be credited to your account and redeemed in cash at the end of the experiment. That is, you can only use your current endowment to pay current investment fees. You cannot use any of the accumulated earnings in your account.

The proctor knows the number of rounds but none of the subjects do. You will be told when the experiment is over.

When you have finished reading these instructions please place them face down in front of you. The proctor will go over the procedures and answer any questions when everyone has finished reading their instructions. If you have questions at any time during the experiment please raise your hand and some one will come to you.