Do Sunk Costs Matter?

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April 7, 2007

Abstract. That sunk costs are not relevant to rational decision-making is often presented as one of the basic principles of economics. When people are influenced by sunk costs in their decision-making, they are said to be committing the "sunk cost fallacy." Contrary to conventional wisdom, we argue that, in a broad range of situations, it is rational for people to condition behavior on sunk costs, because of informational content, reputational concerns, or financial and time constraints. Once all the elements of the decision-making environment are taken into account, reacting to sunk costs can often be understood as rational behavior.

JEL Codes: D0, D01, D8, D81, D83, D9, D90.

Keywords: Sunk Costs, Rationality, Information, Reputation, Constraints.

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> "Let Bygones Be Bygones."
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> Khieu Samphan, former head of state of the Khmer Rouge government, asking Cambodians to forget the more than one million people who died under his government's rule.

I. Introduction

Sunk costs are costs that have already been incurred and cannot be recovered. Sunk costs do not change regardless of which action is presently chosen. Therefore, an individual should ignore sunk costs to make a rational choice. Introductory textbooks in economics present this as a basic principle and a deep truth of rational decision-making (Frank and Bernanke, 2006, p. 10, and Mankiw, 2004, p. 297).

Nonetheless, people are apparently often influenced by sunk costs in their decision-making. Once individuals have made a large sunk investment, they have a tendency to invest more in an attempt to prevent their previous investment from being wasted. The greater the size of their sunk investment, the more they tend to invest further, even when the return on additional investment does not seem worthwhile. For example, some people remain in failing relationships because they "have already invested too much to leave." Others buy expensive gym memberships to commit themselves to exercising. Still others are swayed by arguments that a war must continue because lives will have been sacrificed in vain unless victory is achieved.

These types of behavior do not seem to accord with rational choice theory, and are often classified as behavioral errors. People who commit them are said to be engaging in the "sunk cost fallacy." Students are repeatedly taught in economics classes that sunk costs are irrelevant to decision-making so that they may ultimately learn to make better decisions, invoking the theory as a normative prescription. Conditioning on the level of sunk costs is also taken as evidence that people do not always make rational choices (see Thaler, 1991), suggesting that the explanatory power of rational choice theory is limited.

In this paper, we argue that, in a broad range of environments, reacting to sunk costs is actually rational. Agents may rationally react to sunk costs because of informational content, reputational concerns, or financial and time constraints.

Informational Content. Consider a project that may take an unknown expenditure to complete. The failure to complete the project with a given amount of investment is informative about the expected amount needed to complete it. Therefore, the expected additional investment required for fruition will be correlated with the sunk investment. Moreover, in a world of random returns, the realization of a return is informative about the expected value of continuing a project. A large loss, which leads to a rational inference of a high variance, will often lead to a higher option value because option values tend to rise with variance. Consequently, the informativeness of sunk investments is amplified by consideration of the option value.

Reputational Concerns. In team relationships, each participant's willingness to invest depends on the investments of others. In such circumstances, a commitment to finishing projects even when they appear *ex post* unprofitable is valuable, because such a commitment induces more efficient *ex ante* investment. Thus, a reputation for "throwing good money after bad"—the classic sunk cost fallacy—can solve a coordination problem. In contrast to the desire for commitment, people might rationally want to conceal bad choices to appear more talented, which may lead them to make further investments, hoping to conceal their investments gone bad.

Financial and Time Constraints. Given financial constraints, larger past expenditures leave less ability to make future expenditures, *ceteris paribus*. Thus, financial constraints may lead companies or individuals to stick with projects that no longer appear to be the best choice.

Moreover, given limited time to invest in projects, as the time remaining shrinks, individuals have less time over which to amortize their costs of experimenting with new projects, and therefore may be rationally less likely to abandon current projects.

Once all the elements of the decision-making environment are correctly specified, conditioning on sunk costs can often be understood as rational behavior. This has two potentially important implications. First, the sunk cost fallacy is not necessarily evidence that people do not make rational choices. Second, in certain situations, ignoring sunk costs may not be rational, so people should not necessarily or systematically ignore them, or be taught to do so.

The possibility of rational explanations for sunk cost effects has been raised before. Friedman *et al.* (2006) list option values and reputational concerns as possible reasons why people might react to sunk costs. However, they do not provide detailed explanations or models. Kanodia, Bushman, and Dickhaut (1989), Prendergast and Stole (1996), and Camerer and Weber (1999) develop principal-agent models in which rational agents invest more if they have invested more in the past to protect their reputation for ability. We elucidate the general features of these models below and argue that concerns about reputation for ability are especially powerful in explaining apparent reactions to sunk costs by politicians. Carmichael and MacLeod (2003) develop a model in which agents initially make investments independently and are later matched in pairs, their match produces a surplus, and they bargain over it based on cultural norms of fair division. A fair division rule in which each agent's surplus share is increasing in their sunk investment, and decreasing in the other's sunk investment, is shown to be evolutionarily stable.

Although several papers have raised the possibility of rational and evolutionary reasons, and several have modeled one reason, for attending to sunk costs, our paper appears to be the first to systematically model the main rational reasons for doing so. Before presenting our formal arguments about the rationality of reacting to sunk costs in different decision-making environments, we now review the empirical evidence on the tendency to react to sunk costs.

II. Empirical Evidence

The greater the sunk investment that individuals have already made, the more likely they are to invest further. Several studies provide empirical evidence of this tendency. In studies by Staw (1976, 1981), Arkes and Blumer (1985), Whyte (1993), and Khan, Salter, and Sharp (2000), subjects were presented with various vignettes describing a business investment project. One group of subjects was told that a large amount had already been invested, while another group was told that a small amount had already been invested. In almost all the cases, the subjects with the large sunk investment chose to invest more.

Individuals who have made a large sunk investment may also have a tendency to invest further even when the return does not seem worthwhile. According to evidence reported by De Bondt and Makhija (1988), managers of many utility companies in the U.S. have been overly reluctant to terminate economically unviable nuclear plant projects. In the 1960s, the nuclear power industry promised "energy too cheap to meter." But nuclear power later proved unsafe and uneconomical. As the U.S. nuclear power program was failing in the 1970s and 1980s, Public Service Commissions around the nation ordered prudency reviews. From these reviews, De Bondt and Makhija find evidence that the Commissions denied many utility companies even partial recovery of nuclear construction costs on the grounds that they had been mismanaging the nuclear construction projects in ways consistent with "throwing good money after bad."

There is also evidence of government representatives failing to ignore sunk costs. The governments of France and Britain continued to invest in the Concorde—a supersonic aircraft no longer in production—long after it became clear that the project would generate little return, because they had "Too much invested to quit" (Teger, 1980, title of the book).

An argument often made to stay the course in a war is that too many lives have already been lost, and that these lives will have been lost in vain if the war is not won. In a speech on August 22, 2005, U.S. President George Bush made this argument for staying the course in Iraq. Referring to the almost 2,000 Americans who had already died in the war, he said "We owe them something… We will finish the task that they gave their lives for" (Schwartz, 2005, p. 1). Similar arguments were made during the Vietnam War. As casualties mounted in Vietnam in the 1960s, it became more and more difficult to withdraw, because war supporters insisted that withdrawal would mean that too many American soldiers would have died in vain.

Many of the examples usually employed to demonstrate the sunk cost fallacy consist of disasters resulting from not ignoring sunk costs. The nuclear power program resulted in billions of dollars wasted and expensive energy, and the Vietnam War resulted in tens of thousands of American deaths and merely postponed the time until South Vietnam fell. The choice of examples may in part reflect a bias on the part of economists and psychologists trying to teach people a lesson about ignoring sunk costs. A potentially very effective way to teach people to ignore sunk costs is through examples in which people did not ignore sunk costs much to society's, or their own, ultimate detriment.

But there are also examples of people who succeeded by not ignoring sunk costs. The same "we-owe-it-to-our-fallen-countrymen" logic that led Americans to stay the course in Vietnam also helped the war effort in World War II. More generally, many success stories involve people who at some time suffered great setbacks, but persevered when short-term odds were not in their favor because they "had already come too far to give up now." Columbus did not give up when the shores of India did not appear after weeks at sea, and many on his crew were urging him to turn home (see Olson, 1967, for Columbus' journal). Jeff Bezos, founder of Amazon.com, did not give up when Amazon's loss totaled $1.4 billion in 2001, and many on Wall Street were speculating that the company would go broke (see Mendelson and Meza, 2001).

Anecdotal evidence suggests that individuals may even exploit their own reactions to sunk expenditures to their advantage. Steele (1996, p. 610) and Walton (2002, p. 479) recount stories of individuals who buy exercise machines or gym memberships that cost in the thousands of dollars, even though they are reluctant to spend this much money, reasoning that if they do, it will make them exercise, which is good for their health. A reaction to sunk costs that assists in commitment is often helpful.

People react to sunk costs not only in investment decisions, but also in consumption decisions. In consumption, people may attempt to redeem sunk monetary expenditures by increasing non-monetary expenditures of resources such as time and effort. In a field experiment with season tickets to the Ohio University's Theater in 1982, Arkes and Blumer (1985) found that people who were charged the regular price of $15 (about $30 in 2006 dollars) at the ticket counter attended 0.83 more plays on average, out of the first five plays of the season, than those who received an unexpected discount of $7 ($14 today). Staw and Hoang (1995) and Camerer and Weber (1999) show that NBA teams initially tend to give their early-round draft picks more playing time than their performance justifies, perhaps in an attempt to justify their high salaries .

People may invest more money or time if their sunk costs are greater ("escalation of commitment"), but they may also invest less if their sunk costs are greater ("de-escalation"). While the reported evidence typically points to escalation, Garland, Sandeford, and Rogers (1990) provide evidence of de-escalation in oil exploration experiments. The authors gave petroleum geologists various scenarios in which more or fewer wells had already been drilled and found to be dry. The geologists were less likely to authorize funds to continue exploration, and their estimates of the likelihood of finding oil in the next well were lower, when the number of wells already found to be dry was greater. Similarly, Heath (1995) provides evidence of de-escalation in several experiments with investment vignettes. He attributes the observed "reverse sunk cost effect" to "mental budgeting." According to his theory, people set a mental limit for their expenditures, and when their expenditures exceed the limit, they quit investing. People who have already invested a lot are more likely to have reached the limit of their mental budget, and therefore are more likely to quit. We argue later that actual budget constraints can explain not only de-escalation but also escalation of commitment in certain investment situations.

Empirical and anecdotal evidence suggests that people are often influenced by sunk costs in their decision-making. We now argue that this is not necessarily inconsistent with rational decision-making or optimizing behavior.

III. Informational Content

Agents may rationally react to sunk costs because such costs reveal valuable information, both about the likelihood of future success, and about the option value of continuing to invest.

A. Changing Hazards

Past investments in a given course of action often provide evidence about whether the course of action is likely to succeed or fail in the future. Other things equal, a greater investment usually implies that success is closer at hand.

Consider the following simple model. A firm has an investment project that requires a total cost $\bar{C}$ to complete, and yields a payoff V upon completion. The total cost $\bar{C}$ is uncertain, and is distributed according to a cumulative distribution function $G(\bar{C})$, where $G(x) > G(y)$ for $x > y > 0$. Suppose the firm has already invested an amount C_1 in period 1, and the project is not complete. In period 2, the firm chooses whether or not to invest an additional amount C_2. For simplicity, suppose the firm cannot invest after period 2. Denote by p_2 the probability that the project is completed after the firm invests in period 2.

Using Bayes' Law, we find that

$$p_2 = p_2(C_1, C_2) = \frac{G(C_1 + C_2) - G(C_1)}{1 - G(C_1)}.$$

This is the *cumulative hazard* of investment, and it depends on the amount C_1 already invested. The firm therefore rationally takes into account the size of its sunk investment when deciding whether to invest further.

Differentiating $p_2(C_1, C_2)$ with respect to C_1, we obtain

$$\frac{\partial p_2}{\partial C_1} = \frac{1 - G(C_1 + C_2)}{1 - G(C_1)} \left(\frac{g(C_1 + C_2)}{1 - G(C_1 + C_2)} - \frac{g(C_1)}{1 - G(C_1)} \right).$$

Thus, $p_2(C_1, C_2)$ is increasing in C_1 if the hazard rate $\frac{g(\bullet)}{1 - G(\bullet)}$ is increasing. That is, conditional on not succeeding, the probability of success with a small additional investment grows, and conversely $p_2(C_1, C_2)$ is decreasing in C_1 if the hazard rate is decreasing.

The firm's expected utility of investing in period 2 is $p_2(C_1, C_2)V - C_2 - C_1$, and its expected utility from not investing in period 2 is $-C_1$. Therefore, the net gain from investment in period 2 is $p_2(C_1, C_2)V - C_2$.

Suppose the hazard rate is increasing, so $p_2(C_1, C_2)$ is increasing in C_1. In this case, the willingness to invest is rationally an increasing function of the past investment. Similarly, the willingness to invest is rationally a decreasing function of the past investment if the hazard rate is decreasing. The only case in which the size of the sunk investment cannot affect the firm's rational decision about whether to continue investing is the rather special case in which the hazard is exactly constant.

The model suggests that in many environments, the level of sunk costs matters to the rational inference about the likely needed future expenditures, and in such environments, sunk costs matter. The theory admits that the effect of sunk costs on the willingness to make continued investments is ambiguous, hinging on the derivative of the hazard rate.

If the amount required for the project to be completed cannot exceed some known finite amount, that is, the support of the distribution of $\overline{C}$ has an upper bound, then the project's hazard rate is necessarily increasing close to this upper bound. Even when the upper bound is not known with certainty, the hazard might be increasing. In many investment projects, progress toward the goal is observable or measurable. Sunk investments that have been insufficient to achieve success then convey information about the likelihood of future success. Consider an aircraft company engaged in a project to develop "a radar scrambling device that would render a plane undetectable by conventional radar" (Arkes and Blumer, 1985). Suppose the firm has spent \$100 million to develop the radar-blank plane, and while it has not achieved its goal yet, the project is now 90 percent complete in that, according to test results that incorporate many variations in speed, altitude, and the level of electromagnetic emissions, the plane is detectable only about 10 percent of the time, which is slightly above the marketable level of 5 percent. The firm must decide whether to invest another \$100 million. While this might still be insufficient to complete the project, the firm might expect a high probability of completion with the additional investment based on the substantial progress achieved through the first $100 million invested.

Learning by doing generally reinforces the conclusion that greater expenditures should increase the willingness to continue. In the model described above, if the firm has invested more in period 1, it may have acquired more knowledge and skill that will make it more likely to succeed with the additional investment in period 2. That is, the probability that the firm will succeed in period 2 may also be a function of the firm's ability in period 2, a_2, which may be a function of C_1. A greater investment in period 1 may increase ability, so $da_2 / dC_1 > 0$, which makes it more likely that $dp_2 / dC_1 > 0$.

While some projects have an increasing hazard, others appear to have a decreasing hazard. For example, curing cancer, originally expected to cost $1 billion (see Epstein, 1998), probably has a decreasing hazard; given initial failure, the odds of immediate success recede and the likely expenditures required to complete grow. Oil-exploration projects might also be characterized by decreasing hazards. Suppose a firm acquires a license to drill a number of wells in a fixed area. It decides to drill a well on a particular spot in the area. Suppose the well turns out to be dry. The costs of drilling the well are then sunk. But the dry well might indicate that the likelihood of striking oil on another spot in the area is low since the geophysical characteristics of surface rocks and terrain for the next spot are more or less the same as the ones for the previous spot that turned out to be dry. Thus, the firm might be rationally less likely to drill another well. In general, firms might be less willing to drill another well the more wells they had already found to be dry. This may in part explain the rapid "de-escalation" observed by Garland, Sandeford, and Rogers (1990) in their oil-exploration experiments.

B. Option Values

Experience generally reveals information about likely future values. In a world of uncertainty, maintaining an investment generates information, while terminating often does not. Therefore, there may be an *option value* to maintaining investments (Pindyck, 1991, Dixit, 1992, and Dixit & Pindyck, 1994).

A firm may start a project because the project has a positive net present value (NPV), and then experience a bad outcome that turns the NPV negative; but it might nonetheless be rational for the firm to continue investing in the project after the bad outcome because of the "deferral" option value of maintaining the investment. Consider the following simple three-period example. In period 1, the firm chooses whether or not to invest $\$2$ in a project. If it chooses to invest, then with $1/2$ probability the project is completed and yields $\$6$, and with $1/2$ probability the project is not completed. If the project is not completed, then in period 2, the firm chooses whether or not to invest another $\$2$. If it chooses to invest, then with $1/2$ probability the project is now completed and yields $\$6$, and with $1/2$ probability the project is still not completed and the firm learns that an additional $\$10$ is required for completion. If the firm ever chooses not to invest before completion, it receives zero.

Ignoring discounting, in period 1, the NPV of the project, which is calculated under the assumption that the firm either never invests or invests until completion, is $-2 + 0.5(6) + 0.5[-2 + 0.5(6) + 0.5(-10 + 6)] = 0.5$, and in period 2, after the bad outcome in period 1, the NPV of the project is $-2 + 0.5(6) + 0.5(-10 + 6) = -1$. However, in period 2, the true value of continuing the project after the bad outcome in period 1, which includes the value of the deferral option, is $-2 + 0.5(5) + 0.5(0) = 0.5$, since the firm can stop investing in period 3 if it learns that an additional $\$10$ is required for completion. Thus, even in the bad state after the first round, which makes the project's NPV turn negative, it is rational for the firm to continue investing because of the deferral option value of maintaining the investment.

In investment projects where option considerations are important, larger losses themselves might even be "good news" about the value of further investment. This is an extreme form of our argument that it might be rational to "throw good money after bad." We illustrate the logic in a simple way. Suppose that an investment project is one of two kinds, either with low risk and negative profit, or high risk and positive profit. For simplicity, suppose the low-risk project has a normally distributed return with mean μ_L and variance s^2, while the high-risk project return is also normally distributed with mean μ_H and variance σ^2. Assume $s^2 < \sigma^2$ and $\mu_L < 0 < \mu_H$, so that the goal of the investor is to terminate the low-risk project and continue with the high-risk project.

Given an observed return x and a prior on the high return of p, the Bayesian update that the project has a positive return is

$$\frac{p\frac{1}{\sqrt{2\pi}\sigma}e^{\frac{-(x-\mu_H)^2}{2\sigma^2}}}{p\frac{1}{\sqrt{2\pi}\sigma}e^{\frac{-(x-\mu_H)^2}{2\sigma^2}}+(1-p)\frac{1}{\sqrt{2\pi}s}e^{\frac{-(x-\mu_L)^2}{2s^2}}}=\frac{1}{1+\frac{1-p}{p}\frac{\sigma}{\sqrt{2\pi}s}e^{\frac{(x-\mu_H)^2}{2\sigma^2}-\frac{(x-\mu_L)^2}{2s^2}}}.$$

This probability is increasing in x if $\frac{(x-\mu_H)^2}{2\sigma^2}-\frac{(x-\mu_L)^2}{2s^2}$ is decreasing. As $s^2 < \sigma^2$, the Bayesian update is increasing if $x > \frac{\sigma^2\mu_L - s^2\mu_H}{\sigma^2 - s^2}$. For x below $\frac{\sigma^2\mu_L - s^2\mu_H}{\sigma^2 - s^2}$, a *lower* return is "good news" about the prospects for investment; the expected payoff from future investment increases as the return decreases. In this case, the lower return signals an increase in variance, which is good news about the value of further experimentation. For any fixed cost of sampling, the stopping rule involves a low Bayesian update, and this occurs on an interval with a very high or a very low return leading to further sampling. Thus, "throwing good money after bad" can readily be an optimal response to the increased option value of a high variance.

In most projects there is uncertainty, and restarting after stopping entails costs, making the option to continue valuable. This is certainly the case for nuclear power plants, for example. Shutting down a nuclear reactor requires dismantling or entombment, and the costs of restarting are extremely high. Moreover, the variance of energy prices has been quite large. The option of maintaining nuclear plants is therefore potentially valuable. Low returns from nuclear power in the 1970s and 1980s might have been a consequence of the large variance, suggesting a high option value of maintaining nuclear plants. This may in part explain the evidence (reported by De Bondt and Makhija, 1988) that managers of utilities at the time were so reluctant to shut down seemingly unprofitable plants.

IV. Reputational Concerns

Agents may also rationally react to sunk costs because of reputational concerns. There are two main classes of relevant reputational concerns: a reputation for commitment, and a reputation for ability.

A. Reputation for Commitment

Refusing to abandon projects with large sunk costs might be rational because it creates a reputation for commitment. In a team situation, should one agent abandon a joint project, the other team members suffer as well. In such a complementary situation, the willingness to persist with projects with large sunk costs might act as a commitment, inducing investment by the other team members.

For example, in cartels and in marriage, an important aspect of the incentive to participate and invest in the relationship is the belief that the other party will stay in the relationship. If a member of an illegal price-fixing cartel seems likely to confess to the government in exchange for immunity from prosecution, the other cartel members may race to be first to confess, since only the first gets immunity (in Europe, such immunity is called "leniency"). Similarly, a spouse who loses faith in the long-term prospects of a marriage invests less in the relationship, thereby reducing the gains from partnership, potentially dooming the relationship. In both cases, beliefs about the future viability matter to the success of the relationship, and there is the potential for self-fulfilling optimistic and pessimistic beliefs.

In such a situation, individuals may rationally select others who stay in the relationship beyond the point of individual rationality, if such a commitment is possible. Indeed, *ex ante* it is rational to construct exit barriers like costly and difficult divorce laws, so as to reduce early exit. Such exit barriers might be behavioral as well as legal. If an individual can develop a reputation for sticking in a relationship beyond the break-even point, it would make that individual a more desirable partner and thus enhance the set of available partners, as well as encourage greater and longer lasting investment by the chosen partner.

One way of creating such a reputation is to act as if one cares about sunk costs. In some sense, the history of a relationship is a sunk cost (or benefit); if a person conditions on this history in a way that makes him or her stay in relationships that have a zero or slightly negative expected value going forward, the person has created an exit barrier.

This logic establishes the value of conditioning on sunk costs, or, more realistically, sunk benefits, in the context of co-investment and partnership selection. An individual who uses the logic of "stay in the relationship until the total value, including the sunk value, generated by the relationship is zero" will be a more desirable partner than the individual who leaves when the value going forward is zero. We now formalize this concept using a simple two-period model that sets aside consideration of selection.

An agent matches with another agent, possibly for two periods. The match is an agreement to share the sum of payoffs equally, and therefore the matched agents maximize their joint payoffs. In period 1, both agents sink investments x and y respectively, which produce returns for each of $\frac{1}{2}\sqrt{xy}$, and cost $\frac{1}{2}x^2$ and $\frac{1}{2}y^2$, respectively. Investment only occurs in the first period. The returns are repeated in the second period, provided both agents remain in the relationship. In period 2, with probability p, each agent is offered the opportunity to break the relationship for the return V. The outside offers to agents are independent. Each agent learns whether or not he or she has an outside offer (but does not learn whether or not the other has one), and then chooses whether or not to breach the relationship. If one agent takes an outside offer but the other agent does not receive one, the latter obtains zero. For each agent, breaching the relationship also entails a reputation cost ρ, as it reduces the agent's reputation for commitment and desirability as a partner in future matches.

If both agents breach when given the opportunity to do so in period 2, then the probability that both agents breach in period 2 is p^2, the probability that exactly one agent breaches is $2p(1-p)$, and the probability that no agent breaches is $(1-p)^2$. Thus, ignoring discounting, the sum of payoffs is $u = (1+(1-p)^2)\sqrt{xy} + 2p(V-\rho) - \frac{1}{2}x^2 - \frac{1}{2}y^2$, which is maximized when $x = y = ½(1+(1-p)^2)$. An agent who breaches receives $V - \rho$ in period 2. An agent who does not breach receives $\frac{1}{2}\sqrt{xy} = \frac{1}{4}\left(1+(1-p)^2\right)$ in period 2 if the other agent does not breach, which happens with probability $1-p$, and receives 0 if the other agent breaches, which happens with probability p, under the hypothesis that the other agent breaches given the opportunity to do so. Thus, an agent who breaches in period 2 receives $\frac{1}{2}\sqrt{xy}(1-p) = \frac{1}{4}\left(1+(1-p)^2\right)(1-p)$ if the other agent breaches given the opportunity to do so. Therefore, breaching is subgame-perfect if $V - \rho > \frac{1}{4}\left(1+(1-p)^2\right)(1-p)$.

If neither agent breaches given the opportunity to do so, then the sum of payoffs is $u = (2\sqrt{xy}) - \frac{1}{2}x^2 - \frac{1}{2}y^2$, which is maximized when $x = y = 1$. In this case, an agent who does not breach receives $\frac{1}{2}\sqrt{xy} = \frac{1}{2}$ in period 2 given that the other agent does not breach in period 2. Thus, not breaching is subgame-perfect if $V - \rho < \frac{1}{2}$.

Consequently, if $\frac{1}{2} > V - \rho > \frac{1}{4}\left(1+(1-p)^2\right)(1-p)$, then there are two subgame perfect equilibria, one with breaching and without breaching. The "no breaching" equilibrium offers both parties higher payoffs. It results from self-fulfilling optimistic beliefs. Given that the agents expect each other not to breach in period 2, they invest more in period 1, which in turn makes them want to continue (escalate) the relationship in period 2. On the other hand, the breaching equilibrium results from self-fulfilling pessimistic beliefs. Given that the agents expect each other to breach in period 2, they invest less in period 1, and as a consequence they do not have sufficient incentive to continue the relationship in period 2. Note that, looking across these two equilibria, one would see escalation of commitment: when the investment is small, the relationship breaks up, and when the investment is large, the relationship continues. If one took a sample of similar relationships, some might be in the breaching equilibrium, where little is invested and the relationship dissolves, while some might be in the no breaching equilibrium, where a lot is invested and the relationship lasts. Then, if one regressed the probability of dissolution on the amount invested, one would obtain a positive correlation.

In situations where the reputation cost ρ from breaching the relationship is large enough that $V-\rho < \frac{1}{4}\left(1+(1-p)^2\right)(1-p)$, only the no breaching equilibrium is subgame perfect. Thus, rational concerns about reputation for commitment might eliminate the breaching equilibrium. The agents might rationally avoid breaching the relationship even when a great outside option presents itself because they want to protect their reputation for commitment, which makes both agents invest more initially, which in turn reduces both agents incentives to breach when an outside option arises, leading to the better, no breaching equilibrium.

On the other hand, in situations where the reputation cost ρ of breaching is low enough that $V-\rho > \frac{1}{2}$, breaching is the only subgame perfect equilibrium. In this case, the total gains from trade are $u^* = \frac{1}{4}\left(1+(1-p)^2\right)^2 + 2p(V-\rho)$. This function is decreasing around $p=0$ unless $V-\rho$ exceeds 1. That is, a slight possibility of breach is collectively harmful; both agents would be *ex ante* better off if they could prevent breach when $V-\rho<1$, which holds as long as the reputation cost ρ of breaching is not too small. In this model, a tendency to stay in the relationship due to a large sunk investment would be beneficial to each party. It would be beneficial for an agent because of the effort it would induce in the other agent, as well as for the increase in the agent's own effort, even when the returns are shared between them. Any mechanism for commitment to stay in the relationship even when the relationship has a negative expected value going forward would serve the agents well.

B. Reputation for Ability

Abandoning a project may also reveal an agent as a poor forecaster, leading agents to rationally persist with unprofitable projects to conceal their poor skills. This argument has already been made formally by several authors, most notably Kanodia, Bushman, and Dickhaut (1989), Prendergast and Stole (1996), and Camerer and Weber (1999).

These models share the following features. Managers choose projects, acquire private information about the productivity of the projects while carrying them out, and choose how much more to invest in them in light of this information. The quality of the private information that they acquire is related to their unobservable ability. Managers learn the productivity of projects more quickly, and choose more productive projects, if their ability is higher. Employers rationally make inferences about their ability from their investment choices.

Because more able managers learn the productivity of projects more quickly, they are more likely to have more productive projects, and thus are more likely to continue investing. Then, if managers stop investing upon learning that the projects are not productive, employers draw a negative inference about their ability, which in turn reduces their earnings opportunities. Once they have started to invest, stopping reveals that they were slow in learning the productivity of the projects, which signals low ability. For this reason, managers may rationally continue investing even after learning that the projects are unprofitable. Employers might, of course, eventually find out that the projects are unprofitable, in which case the managers might be fired. Nonetheless, managers might rationally continue to invest even after learning that the projects are unprofitable, in order to delay being fired, as long as they discount the future.

Employers would certainly prefer that their managers immediately cease bad projects. They could prevent them from continuing bad projects if they could credibly promise not to fire them if they stopped. However, such a promise is usually not credible. If the managers stop, the employers learn that the projects are likely bad, and therefore the managers who chose them likely have low ability, in which case the employers are often better off firing the managers.

Low ability managers start projects because there is always the chance that they would be lucky and choose good ones. Once they start, they do not want to stop if they learn that the projects are bad because they want to delay a negative inference about their ability, and the associated loss in their earnings potential.

Career concerns might be especially powerful in explaining the evidence that politicians often “throw good money after bad.” Politicians are agents for the people and choose projects for the provision of public goods and the protection of national interests. However, they differ in their ability to choose good projects, receive private information about the quality of their chosen projects, make public decisions about whether to continue them, and continue to benefit from being in power only if they can maintain a good reputation. Moreover, politicians are in a position where they heavily discount the future if their reelection is not assured. If they can maintain their reputation until the reelection date, they may remain in power. If they learn some time before the reelection date that one of their projects is bad, they are likely to continue the project to avoid a reputation loss at least until after the reelection.

Politicians might continue a bad project to delay a reputation loss especially if they are more interested in remaining in power than serving the public. Ironically, when ultimately the project is discovered to be bad and they incur the reputation loss, some among them who are especially crooked and calculating might even turn and argue, as Khieu Samphan did (see the introductory quotation on p. 1), that the public should “let bygones be bygones” and ignore the sunk costs of the failed project. However, it is not rational for voters to forget their failure, even though its costs are sunk, because the failure is indicative of a propensity to fail again in the future. Moreover, politicians who argue, like Khieu Samphan, that a very large sunk cost, such as more than one million lives lost, should be forgotten lose all reputation for commitment, which also makes any continued political relationship with them very difficult to justify.

Lastly, reputation concerns may in part explain some reactions to sunk costs in consumption. People who buy an exercise machine that costs thousands of dollars, and then only use it a few days, or buy season tickets to the theater, and then only attend a few plays, might make their lapse of judgment manifest to others (for example, to their spouse), and lose their reputation for making smart consumption choices. To avoid or delay the reputation loss, they might rationally make greater use of their past purchases than they would otherwise want to.

V. Financial and Time Constraints

We have seen that moral hazard in the form of career concerns can lead managers to persist with unprofitable projects. In general, moral hazard and asymmetric information can create a host of managerial problems, to which firms rationally respond by imposing financial constraints on managers. Abundant theoretical literature in corporate finance shows that imposing financial constraints on firm managers improves agency problems (see Stiglitz and Weiss, 1981, Myers and Majluf, 1984, Lewis and Sappington, 1989, and Hart and Moore, 1995). The theoretical conclusion finds overwhelming empirical support, and only a small fraction of business investment is funded by borrowing (see Fazzari and Athey, 1987, Fazzari and Peterson, 1993, and Love, 2003). When managers face financial constraints, sunk costs must influence firm investments simply because of budgets.

Firms with financial constraints might rationally react to sunk costs by investing more in a project, rather than less, because the ability to undertake alternative investments declines in the level of sunk costs. Consider the following simple model. A firm with a budget of $B > 0$ dollars is engaged in an investment opportunity, project 1, which requires paying a fixed cost $M_0 > 0$ before yielding a rate of return of $R_1 > 0$ on every dollar spent beyond M_0. The firm is making payments in increments across time. Now suppose that a better investment opportunity, project 2, arises unexpectedly. Project 2 is better than project 1 in the sense that it has the same fixed cost M_0 but a higher rate of return $R_2 > R_1$. Project 2 arises unexpectedly in the sense that, initially, the probability that it would arise was low enough that the firm found it worthwhile to start project 1 (instead of waiting for project 2).

Let $M_1 > 0$ be the amount that the firm has already sunk into project 1 at the time that project 2 arises. If $M_1 > M_0$, then the firm switches to project 2 if and only if $(B - M_1)R_1 < (B - M_0 - M_1)R_2$, or equivalently, $M_0 R_2 < (B - M_1)(R_2 - R_1)$. If $M_1 < M_0$, then the firm switches to project 2 if and only if $(B - M_0)R_1 < (B - M_0 - M_1)R_2$, or equivalently $M_1 R_2 < (B - M_0)(R_2 - R_1)$. In either case, the firm rationally continues with project 1 (the inequality is not satisfied) if the amount M_1 that the firm has already sunk into project 1 is sufficiently large, and switches to project 2 (the inequality is satisfied) if M_1 is sufficiently small. The firm also continues with project 1 if the fixed cost M_0 to obtain a return on a project is sufficiently large, or if the firm's budget B is sufficiently small.

Given limited resources, if the firm has already sunk more resources into the current project, then the value of the option to start a new project if it arises is lower relative the value of the option to continue the current project, because fewer resources are left over to bring any new project to fruition, and more resources have already been spent to bring the current project to fruition. Therefore, the firm's incentive to continue investing in the current project is higher the more resources it has already sunk into the project.

Financial constraints induce an option value of continuing a project. With an unlimited budget, no one would ever want to return to an abandoned project, because the decision to abandon a project means that search is preferable to the project. With a limited budget, however, it becomes desirable to reverse a decision to abandon a project as the budget shrinks; in such cases, the existing project has an option value. In the above model, the option value is created only by the limited budget and would not be present with an unlimited budget. In contrast, in the models of Section III.B, the option values are present even with an unlimited budget.

The above model might be germane to several apparent sunk cost fallacies. It might explain why businesses sometimes stick with projects that no longer appear to be the best choice. For example, an aircraft company that had started a project to develop a radar-blank bomber plane might seem overly reluctant to switch to developing a radar-blank fighter plane if stealth fighters are suddenly in much greater demand; but their reluctance might be rational because they might have a limited budget, might have already spent hundreds of millions of dollars on developing a cost-effective bomber, and would have to pay another large fixed cost to develop a cost-effective fighter instead.

Resource constraints may explain apparent sunk costs fallacies not only in business investment, but also in other kinds of investment, for example, in careers. People who have already invested a lot of money and time on a legal education, only to learn that a career in law would not interest them much, might nonetheless persist in this career path instead of switching to another one, such as becoming a doctor, even though a career in medicine might now interest them more, because becoming a doctor requires years in medical school, and they might have already exhausted most of their time, and opportunities for student loans, on their legal education.

With a resource constraint, an individual can only switch to a new project a limited number of times since starting a new project is costly. However, with only one more switch possible, starting a new (better) project entails foreclosing the option to start a new (even better) project in the future, and thus would not be a rational choice unless the gains were sufficiently large—there is substantial "lock-in" even on the penultimate chance. However, using backward-induction, abandoning the third-to-last project means moving to the penultimate one and its substantial lock-in, which means it is suboptimal to abandon the third-to-last project unless the gains are large, and so forth. Ultimately, one should not abandon a project for a small expected gain, which entails rejecting better opportunities to continue with the existing project.

In general, individuals have limited time to devote to investment in projects, and a limited number of attempts at new projects. As the time remaining shrinks, individuals might rationally be more reluctant to abandon current projects to start new ones. Consider the following general model. Time is discrete, with periods $0, 1, 2, ..., T$. At the start of period t, the agent will have an existing project of type v. The agent can stay with the project or choose a new project. Starting a new project means ending the old project and the old project is never recoverable once ended. New projects have a type which is a random draw from a distribution G with density g. This distribution is assumed to have a well-defined mean. A project of type v produces v in every period it is operated. The agent is risk-neutral.

Because old projects are not-recoverable, the agent will use a cut-off strategy and draw a new project if the existing project is worse than a critical value. Denote the critical value at time t by c_t. The agent's utility at the start of period t is $U_t(v) = \max\{v + U_{t+1}(v), E(v + U_{t+1}(v))\}$.

Discounting is assumed away for simplicity. Let μ be the mean. It is readily seen that the last critical value is $c_T = \mu$. In the Appendix, we prove that the critical values satisfy:

$$(*) \qquad c_t = \frac{\mu + EU_{t+1}}{T-t+1} = \frac{\mu}{T-t+1} + \frac{T-t}{T-t+1}\left(c_{t+1} + \int_{c_{t+1}}^{\infty} 1 - G(x)dx\right)$$

Moreover, the sequence c_t is decreasing over time, ending at μ. Thus, as the time remaining becomes shorter, the agent becomes progressively more willing to stay with the existing project.

When G is uniform on $[0, 1]$, the sequence is readily computed, and Figure 1 shows the critical values in the last 1000 time periods for this case. The cutoffs decrease steadily for many periods and then drop rapidly as the last period approaches.

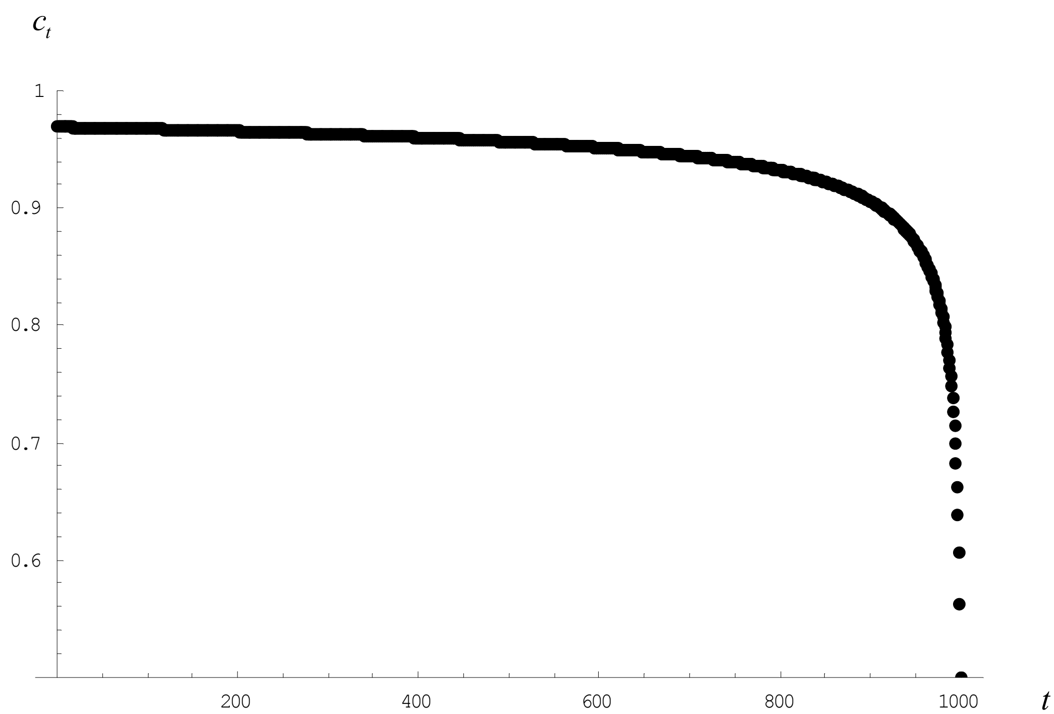

Figure 1: Critical switching values with G uniform on $[0, 1]$ and $T = 1000$.

Intuitively, with many periods remaining, if individuals switch to another project and get a bad draw, then there is ample time for them to make up for it by switching again until the draw is better. But with only a few periods remaining, there is little time to make up for a bad draw. Another way to express the intuition for the result is that, with many periods remaining, individuals can amortize the cost of experimentation over many periods. But with few periods remaining, they can only amortize the experimentation cost over a few periods; and with only one period remaining, they cannot amortize it at all. Thus, as the time remaining shrinks, individuals become rationally more reluctant to abandon current projects.

This logic might also help explain instances of apparent escalation of commitment. For example, people have limited time to invest in education because ability to learn deteriorates rapidly after a certain age. As the time they have remaining shrinks, they might rationally become more reluctant to switch fields of study (even if their satisfaction with their current field of study is not great) because they have less time remaining to amortize the cost of experimenting with new fields of study.

VI. Conclusion

In a world of uncertainty, future prospects are informed by past decisions. In a world of scarce resources and finite time, future prospects are limited by past decisions. In a world of social interaction, future prospects are determined by the reputation that is determined by past decisions. Therefore, reacting to past decisions, and the sunk costs that they have entailed, is often rational.

In this paper, we have shown that people might rationally invest more if they have invested more in the past, because greater past investments often indicate that success is closer at hand, and often reduce the ability or willingness to undertake alternative investments given the presence of financial and time constraints. We have shown that people might rationally "throw good money after bad," either because of the high risks, and therefore high option values of continuing to invest, which large losses often indicate, or to avoid immediately losing their reputation for smart investment choices. And we have shown that people might rationally react to sunk costs to create a reputation for commitment, which tends to improve their welfare in joint investment situations, by encouraging others to choose them as partners, and their partners to invest more.

In addition, any of these reasons could be subject to evolutionary selection; that is, people who are hard-wired to condition their behavior on sunk costs in a given set of situations could do better than people who are not, so that a preference for conditioning on sunk costs might prosper. If the target of evolutionary selection permits it, responding to sunk costs would be rational given such a preference. An evolutionary selection argument has the advantage that people might occasionally condition on sunk costs even when it is disadvantageous do so because, on average, it is advantageous, thus accommodating occasional demonstrably-irrational behavior.

While we have argued that sunk cost effects have a rational explanation, there is also a behavioral explanation for sunk cost effects originally proposed by Thaler (1981) based on the prospect theory of Kahneman and Tversky (1979). Under this theory, people react to losses by investing more because they have loss aversion. The result is explained by a property of preferences. In contrast, we have derived the result from the principles of rationality (Bayesian inference and constrained and dynamic optimization) without building it directly into the preferences. Combining our rational explanation with evolutionary pressures on preferences would reconcile the rational and behavioral approaches to the question.

Although reacting to sunk costs is rational in many situations, ignoring sunk costs is rational in others. According to our models, ignoring sunk costs is rational in any situation in which past investments are not informative, reputation concerns are unimportant, and budget constraints are not salient.

There is no clear evidence that people react to sunk costs in such situations, and some evidence that they do not. Most of the existing empirical work has not controlled for changing hazards, option values, reputations for ability and commitment, and budget constraints. We are aware of only one study in which several of these factors are eliminated—Friedman *et al.* (2006). In an experimental environment without option value or reputation considerations, the authors find only very small and statistically insignificant sunk cost effects in the majority of their treatments, consistent with the rational theory presented here.

Appendix

In this appendix, we derive equation (*) in the text (on page 24), which is the solution to the last model that we develop in Section V. In the model, at the start of the last period, an agent with project v is better off with a new project if v is less the mean project value,

(A1) $$\mu = \int_0^\infty xg(x)dx = \int_0^\infty 1 - G(x)dx .$$

Thus, $c_T = \mu$. The agent's utility at the start of period T is $U_T(v) = \max\{v, c_T\}$, which has expected value over v of

(A2) $$EU_T = G(c_T)c_T + \int_{c_T}^\infty xg(x)dx = c_T + \int_{c_T}^\infty 1 - G(x)dx .$$

This forms the base of an induction. The characterization of the induction is that the agent uses the critical value

(A3) $$c_T = \frac{\mu + EU_{t+1}}{T - t + 1},$$

and

(A4) $$EU_T = (T - t + 1)\left(c_T + \int_{c_T}^\infty 1 - G(x)dx\right).$$

Note this is trivially satisfied at $t = T$.

First, we show that this induction formula implies that the sequence c_t is decreasing in t. We have that $c_t > c_{t+1}$ if and only if

(A5) $$\frac{\mu + EU_{t+1}}{T - t + 1} \geq \frac{\mu + EU_{t+2}}{T - t}$$

if and only if

(A6) $$(\mu + EU_{t+1})(T - t) \geq (\mu + EU_{t+2})(T - t + 1)$$

if and only if

(A7) $$EU_{t+1} \geq \frac{1}{T-t}\mu + \frac{T-t+1}{T-t}EU_{t+2}.$$

This is automatically satisfied because $EU_{t+1} \geq \mu + EU_{t+2}$, a fact that is obvious from $U_t(v) = \max\{v + U_{t+1}(v), E(v + U_{t+1}(v))\}$. Because c_t is a decreasing sequence, if $v > c_t$, then $v > c_s$ for all $s > t$. This simplifies the problem because it means that if the agent does not choose a new project at t, the agent never chooses a new project.

To complete the induction, note that

(A8) $$U_{t-1}(v) = \max\{v + U_t(v), E(v + U_t(v))\} = \max\{(T-t+2)v, \mu + EU_t(v)\}.$$

Thus, the critical value satisfies

(A9) $$c_{t-1} = \frac{\mu + EU_t}{T-t+2},$$

which is consistent with the induction hypothesis. Lastly,

(A10) $$EU_{t-1}(v) = E\max\{(T-t+2)v, \mu + EU_t(v)\} = (T-t)E\max\left\{v, \frac{\mu + EU_t(v)}{(T-t+2)}\right\}$$

$$= (T-t+2)E\max\{v, c_{t-1}\} = (T-t+2)\left(c_{t-1}G(c_{t-1}) + \int_{c_{t-1}}^{\infty} xg(x)dx\right)$$

$$= (T-t+2)\left(c_{t-1} + \int_{c_{t-1}}^{\infty} 1 - G(x)dx\right).$$

This completes the induction.

The induction on the critical values simplifies:

(A11) $$c_t = \frac{\mu + EU_{t+1}}{T-t+1} = \frac{\mu}{T-t+1} + \frac{T-t}{T-t+1}\left(c_{t+1} + \int_{c_{t+1}}^{\infty} 1 - G(x)dx\right),$$

with $c_T = \mu$.

If G is uniform on $[0, 1]$, the sequence is

(A11) $$c_t = \frac{\mu}{T-t+1} + \frac{T-t}{T-t+1}\left(c_{t+1} + \int_{c_{t+1}}^{\infty} 1 - G(x)dx\right)$$

$$= \frac{½ + (T-t)(c_{t+1} + 1 + ½(1-c_{t+1})^2)}{T-t+1}$$

$$= ½\frac{1+(T-t)(1+(c_{t+1})^2)}{T-t+1}.$$

Figure 1 in the text (on page 24) plots these critical values for $T = 1000$.

References

Arkes, Hal R. and Blumer, Catherine, 1985. "The Psychology of Sunk Cost," *Organizational Behavior and Human Decision Processes* 35, 124-140.

Camerer, Colin F. and Weber, Roberto A., 1999. "The Econometrics and Behavioral Economics of Escalation of Commitment: A Re-examination of Staw and Hoang's NBA Data," *Journal of Economic Behavior and Organization* 39, 59-82.

Carmichael, Lorne and MacLeod, Bentley W., 2003. "Caring About Sunk Costs: A Behavioral Solution to Holdup Problems With Small Stakes," *Journal of Law, Economics, and Organization* 19, 106-118.

De Bondt, Werner F. M. and Makhija, Anil K., 1988. "Throwing Good Money After Bad? Nuclear Power Plant Investment Decisions and the Relevance of Sunk Costs," *Journal of Economic Behavior and Organization* 10, 173-199.

Dixit, Avinash K., 1992. "Investment and Hysteresis," *Journal of Economic Perspectives* 6, 107-132.

Dixit, Avinash K. and Pindyck, Robert S., 1994. *Investment Under Uncertainty*. Princeton, NJ: Princeton University Press.

Epstein, Samuel S., 1998. *The Politics of Cancer Revisited*. New York: East Ridge Press.

Fazzari, Steven and Athey, Michael J., 1987. "Asymmetric Information, Financing Constraints, and Investment," *Review of Economics and Statistics* 69, 481-487.

Fazzari, Steven and Petersen, Bruce, 1993. "Working Capital and Fixed Investment: New Evidence on Financing Constraints," *RAND Journal of Economics* 24, 328-342.

Frank, Robert H. and Bernanke, Ben, 2006. *Principles of Microeconomics*. Third Edition, New York, NY: McGraw-Hill.

Friedman, Daniel, Pommerenke, Kai, Lukose, Rajan, Milam, Garrett, and Huberman, Bernardo, 2006. "Searching for the Sunk Cost Fallacy," *Experimental Economics*, Forthcoming.

Garland, Howard, Sandefur, Craig A., and Rogers, Anne C., 1990. "De-escalation of Commitment in Oil Exploration: When Sunk Costs and Negative Feedback Coincide," *Journal of Applied Psychology* 75, 721-727.

Hart, Oliver and Moore, John, 1995. "Debt and Seniority: An Analysis of the Role of Hard Claims in Constraining Management," *American Economic Review* 85, 567-585.

Heath, Chip, 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, 38-54.

Kanodia, Chandra; Bushman, Robert; and Dickhaut, John, 1989. "Escalation Errors and the Sunk Cost Effect: An Explanation Based on Reputation and Information Asymmetries," *Journal of Accounting Research* 27, 59-77.

Khan, Bashir A., Salter, Stephen B., and Sharp, David J. , 2000. "Throwing Good Money After Bad: A Comparison of Asian and Developed Country Managerial Decision-Making in Sunk Cost Situations," *Asian Pacific Development Journal* 7, 105-120.

Kahneman, Daniel and Tversky, Amos, 1979. "Prospect Theory: An Analysis of Decision Under Risk," *Econometrica* 47, 263-291.

Lewis, Tracy and Sappington, David E. M., 1989. "Countervailing Incentives in Agency Problems," *Journal of Economic Theory* 49, 294-313.

Love, Inessa, 2003. "Financial Development and Financing Constraints: International Evidence from the Structural Investment Model," *Review of Financial Studies* 16, 765-791.

Mankiw, N. Gregory, 2004. *Principles of Microeconomics*. Third Edition, Mason, OH: Thomson South-Western.

Mendelson, Haim and Meza, Philip, 2001. "Amazon.com: Marching Toward Profitability," Stanford University Graduate School of Business Case Number EC-25.

Myers, Stewart and Majluf, Nicholas S., 1984. "Corporate Financing and Investment Decisions when Firms Have Information that Investors Do Not Have," *Journal of Financial Economics* 13, 187-221.

Olson, Julius E., 1967. *The Northmen, Columbus and Cabot, 985-1503*. New York: Barnes and Noble.

Pindyck, Robert S., 1991. "Irreversibility, Uncertainty, and Investment," *Journal of Economic Literature* 29, 1110-1152.

Prendergast, Canice and Stole, Lars, 1996. "Impetuous Youngsters and Jaded Old-Timers: Acquiring a Reputation for Learning," *Journal of Political Economy* 104, 1105-1134.

Schwartz, Barry, 2005. "The Sunk-Cost Fallacy: Bush Falls Victim to a Bad Argument for the War in Iraq," *Slate*, September 9.

Staw, Barry M., 1976. "Knee-Deep in the Big Muddy: A Study of Escalating Commitment to a Chosen Course of Action," *Organizational Behavior and Human Performance* 16, 27-44.

Staw, Barry M., 1981. "The Escalation of Commitment to a Course of Action," *Academy of Management Review* 6, 577-587.

Staw, Barry M. and Hoang, Ha, 1995. "Sunk Costs in the NBA: Why Draft Order Affects Playing Time in Professional Basketball," *Administrative Science Quarterly* 40, 474-494.

Steele, David Ramsay, 1996. "Nozick on Sunk Costs," *Ethics,* 605-620.

Stiglitz, Joseph E. and Weiss, Andrew, 1981. "Credit Rationing in Markets with Imperfect Information," *American Economic Review* 71, 393-410.

Teger, A. I., 1980. *Too Much Invested to Quit*. New York: Permagon.

Thaler, Richard, 1980. "Toward a Positive Theory of Consumer Choice," *Journal of Economic Behavior and Organization* 1, 39-60.

Thaler, Richard, 1991. *Quasi-Rational Economics*, New York: Russell Sage Foundation.

Whyte, Glen, 1993. "Escalating Commitment in Individual and Group Decision-Making," *Organizational Behavior and Human Decision Processes* 54, 430-455.

Walton, Douglas, 2002. "The Sunk Cost Fallacy or Argument from Waste," *Argumentation* 16, 473-503.