Electronic Companion to
"A Behavioral Study on Abandonment Decisions in Multi-Stage Projects"

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Online Appendix A: Optimal Policies

In this appendix we formulate the rational models and derive the optimal solutions in FR and LR.

Full Review

We first consider the PM's continue/abandon decisions in FR. The value function in this case is

$$V_t(x_t) = \max\{-c_t + \mathbb{E}V_{t+1}(x_t + w_t), 0\},$$

for $t = 1, \ldots, T-1$, where $\mathbb{E}V_{t+1}(x_t + w_t)$ is the expected value of V_{t+1} with respect to w_t, and $V_T(x) = x$. At stage t, the PM continues the project if and only if $-c_t + \mathbb{E}V_{t+1}(x_t + w_t) > 0$.

We can show that, if the continuation cost is the same at every stage, then a PM who continues the project at stage t will also continue the project at stage $t+1$.

Proposition EC.1. *Assume $c_t = c$. For $t = 1, \ldots, T-2$, if it is optimal to continue at x_t in stage t, then it is optimal to continue at $x_{t+1} = x_t \pm \delta$ in stage $t+1$.*

Proposition EC.1 implies that, for a constant continuation cost, if it is optimal to abandon at $x_{t+1} = x_t - \delta$ or $x_{t+1} = x_t + \delta$ in stage $t+1$ then it is optimal to abandon at x_t in stage t. This statement implies a simple optimal policy: the abandonment threshold a_t is equal to the total cost of completing the project.

Corollary EC.1. *Assume that $c_t = c$. For $t = 1, \ldots, T-1$, the PM continues the project if and only if $x_t > (T-t)c$.*

Proposition EC.1 and Corollary EC.1 together imply that there are two types of projects. First, if $x_1 > (T-1)c$, then the PM should start the project at stage 1 and continue until the project is completed. Second, if $x_1 \leq (T-1)c$, then the project should be abandoned at stage 1.

Limited Review

Now, we consider the LR case. Suppose there are at most M review opportunities for the project ($M < T-2$)—excluding the first stage, at which the PM learns the project's initial value. Denote the value function at stage t by $V_t(x_k, k, n)$, where x_k is the most recently observed project value (in stage k) and n represents the number of review opportunities left, $0 \leq n \leq M$. Define $\Pi_t^i(x_k, k, n)$ as the expected profit from choosing action i at stage t, where $i = \mathrm{C}, \mathrm{A}, \mathrm{R}, \mathrm{NR}$ stand for (respectively) "continue", "abandon", "review", and "no review". Then, for $t = 2, \ldots, T-1$, we have

$$V_t(x_k, k, n) = \begin{cases} \max\{\Pi_t^{\mathrm{R}}(x_k, k, n), \Pi_t^{\mathrm{NR}}(x_k, k, n)\} & \text{if } n > 0; \\ \Pi_t^{\mathrm{NR}}(x_k, k, n) & \text{otherwise.} \end{cases}$$

The value function at stage 1 is $V_1(x_1, 1, M) = \max\{\Pi_1^{\mathrm{C}}(x_1, 1, M), \Pi_1^{\mathrm{A}}(x_1, 1, M)\}$. The value function at stage T is $V_T(x_k, k, n) = \mathbb{E}[x_T \mid x_k, k]$, which is the expected project value upon completion (given that the PM last observed x_k at stage k). The expected profit if the PM does not review the project at stage t is

$$\Pi_t^{\mathrm{NR}}(x_k, k, n) = -c_t + V_{t+1}(x_k, k, n).$$

The expected profit if the PM does review at stage t is

$$\Pi_t^{\mathrm{R}}(x_k, k, n) = \mathbb{E} \max\{\Pi_t^{\mathrm{C}}(x_t, t, n-1), \Pi_t^{\mathrm{A}}(x_t, t, n-1)\};$$

here the expectation is taken over x_t (given that the PM last observed x_k at stage k). The profits from continuing/abandoning the project are, respectively,

$$\Pi_t^{\mathrm{C}}(x_t, t, n) = -c_t + V_{t+1}(x_t, t, n) \quad \text{and} \quad \Pi_t^{\mathrm{A}}(x_t, t, n) = 0.$$

It is easy to see that the optimal continuation policy in Corollary EC.1 applies to this case as well.

Corollary EC.2. *Assume that $c_t = c$. The optimal continuation/abandonment policy under LR is the same as that under FR.*

Online Appendix B: LR Behavioral Model

In this appendix, we formulate the behavioral model for the LR condition, discuss the trade-offs underlying the review decision and describe the estimation procedure.

Behavioral Model

Suppose that x_k and r_k are (respectively) the project value and the reference point from the PM's most recent review stage (stage k). Let n be the number of reviews left. Then the value function can be written as follows:

$$V_t(x_k, r_k, k, n) = \begin{cases} \max\{U_t^{\mathrm{R}}(x_k, r_k, k, n), U_t^{\mathrm{NR}}(x_k, r_k, k, n)\} & \text{if } n > 0, \\ U_t^{\mathrm{NR}}(x_k, r_k, k, n) & \text{otherwise} \end{cases}$$

for $t = 2, \ldots, T-1$ and $V_1(x_1, r_1, 1, M) = \max\{U_1^{\mathrm{C}}(x_1, r_1, 1, M), U_t^{\mathrm{A}}(x_1, r_1, 1, M)\}$. The value function at stage T is $V_T(x_k, r_k, k, n) = \mathbb{E}[x_T + m(x_T - r_T) \mid x_k, r_k, k]$, which is the expected utility over x_T given that the PM last observed x_k at stage k; the reference point is updated as $r_T = \theta r_k + (1-\theta)x_k$.

The expected utility from not reviewing is $U_t^{\mathrm{NR}}(x_k, r_k, k, n) = -c_t + V_{t+1}(x_k, r_k, k, n)$, whereas the expected utility from reviewing is

$$U_t^{\mathrm{R}}(x_k, r_k, k, n) = \mathbb{E}\max\{U_t^{\mathrm{C}}(x_t, r_t, t, n-1), U_t^{\mathrm{A}}(x_t, r_t, t, n-1)\};$$

here the expectation is with respect to x_t (given that the PM last observed x_k at stage k) and the reference point is $r_t = \theta r_k + (1-\theta)x_k$. The utilities from continuing or abandoning the project are, respectively,

$$U_t^{\mathrm{C}}(x_t, r_t, t, n-1) = -c_t + m(x_t - r_t) + V_{t+1}(x_t, r_t, t, n-1), \quad \text{and} \quad U_t^{\mathrm{A}}(x_t, r_t, t, n-1) = m(x_t - r_t) - A - B\sum_{i=1}^{t-1} c_i.$$

Review Decision

For the rational PM, a review is valuable if it provides information that could lead to an abandonment decision. For the reference-dependent PM, however, a review can also affect his reference point and hence the gain–loss utility. So even when the PM continues at every stage (i.e., when reviews carry no decision-making value), he may still strictly prefer to review at an earlier or later stage, as shown in the following example.

Example 1. *Let $T = 4$, and let parameters A and B be sufficiently large such that the PM always continues the project. Suppose there is only one review opportunity ($M = 1$). If $\lambda > 1$, then reviewing at stage 3 is strictly preferred to reviewing at stage 2; if $\lambda < 1$, then reviewing at stage 2 is strictly preferred to reviewing at stage 3.*

When making the decision to review earlier or later in a project, the reference-dependent PM considers the two effects of review: (1) incurring a gain-loss utility and (2) updating the reference point. In particular, the updated reference point affects the psychological impact of subsequent information (gain-loss utility in the next review). For example, in a 4-stage project, if the PM reviews at stage 2, then he experiences a small gain-loss utility in stage 2 but may experience a large gain or loss upon project completion (at stage 4). In contrast, if the PM reviews at stage 3, he is likely to experience a larger gain-loss utility at stage 3 (compared with reviewing at stage 2) but smaller gains or losses upon project completion. Further, in this case, the reduction in expected gain-loss utility at $T = 4$ outweighs the increase in expected gain-loss utility at $T = 3$. Thus if the PM is gain-seeking, he prefers a large gain-loss utility at $T = 4$ and would review early at stage 2, whereas a loss-averse PM would try to avoid large gains and losses by reviewing later. The same intuition applies to longer-length projects, as illustrated via simulation in Figure 1.

Estimation

We assume the participant chooses to review at stage t of project i if and only if $U_{it}^{\mathrm{R}} - U_{it}^{\mathrm{NR}} + v_{itj} > 0$; here the noise term v_{itj} is an i.i.d. normally distributed random variable with mean 0 and variance $1/(s_2)^2$. Therefore,

$$P_{itj}(\text{review}) = \Phi(s_2(U_t^{\mathrm{R}} - U_t^{\mathrm{NR}})); \quad \text{and} \quad P_{itj}(\text{no review}) = \Phi(s_2(U_t^{\mathrm{NR}} - U_t^{\mathrm{R}})). \tag{EC.1}$$

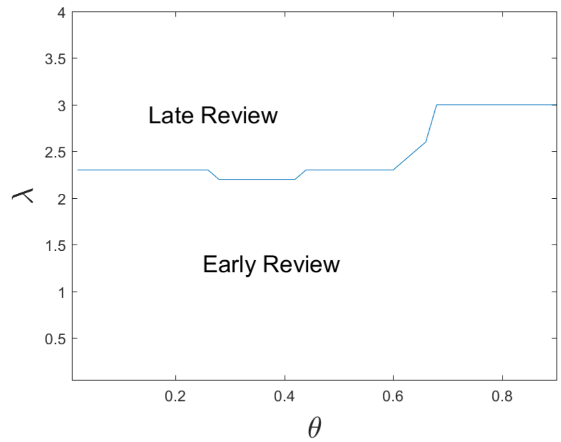


Figure 1: First review decision ($\gamma = 2.3$, $A = 71.42$, $B = 0.58$, $s_1 = 0.018$, $s_2 = 0.05$, $c = 11$, $\delta = 10$) in an 8-stage project with $x_1 = 70$ and $M = 2$. We change λ (from 0.1 to 3.5 in increments of 0.1) and θ (from 0.01 to 1 in increments of 0.01). In the region "Early Review", the probability of reviewing in the second or third stage is greater than 0.5.

As in Section 4.3 of the paper, we have

$$P_{itj}(\text{continue} \mid \text{review}) = \Phi(s_1(U_t^{\mathrm{C}} - U_t^{\mathrm{A}})); \quad \text{and} \;\; P_{itj}(\text{abandon} \mid \text{review}) = \Phi(s_1(U_t^{\mathrm{A}} - U_t^{\mathrm{C}})),$$

and the log-likelihood function is written as

$$\begin{aligned}\mathrm{LL}_{\mathrm{LR}} = \sum_{i=1}^{32}\sum_{t=1}^{T_i}\sum_{j=1}^{N_2} c_{itj}\big(a_{itj}b_{itj}\log P_{itj}(\text{continue} \mid \text{review}) + (1-a_{itj})b_{itj}\log P_{itj}(\text{abandon} \mid \text{review}) \\ + b_{itj}\log P_{itj}(\text{review}) + (1-b_{itj})\log P_{itj}(\text{no review})\big).\end{aligned}$$

Here $N_2 = 38$ is the number of participants in the LR experiment. Let $b_{itj} = 1$ if participant j reviews project i at stage t (with $b_{itj} = 0$ otherwise) and $c_{itj} = 1$ if the number of review opportunities left for participant j at stage t of project i is positive (with $c_{itj} = 0$ otherwise).

Online Appendix C: Proofs

Proof of Lemma 1. It suffices to prove that $V_t(x)$ (formulated in Online Appendix A) is increasing in x for $t = 1, 2, \ldots, T-1$. First, observe that $V_T(x) = x$ is increasing in x. Second, for $t = 1, 2, \ldots, T-1$, if $V_{t+1}(x)$ is increasing in x, then $V_t(x) = \max\{-c_t + \mathbb{E}[V_{t+1}(x + w_t)], 0\} = \max\{-c_t + \frac{1}{2}V_{t+1}(x+\delta) + \frac{1}{2}V_{t+1}(x-\delta), 0\}$ is increasing in x. This completes the proof. ∎

Proof of Proposition 1. (i) The proof is similar to that of Lemma 1 and so is omitted for brevity. (ii) We use backward induction to show that $V_t(x_t, r_t)$ is decreasing in r_t. First, observe that $V_T(x_T, r_T) = x_T + m(x_T - r_T)$ is decreasing in r_T. Next, for $t = 1, \ldots, T-1$, if $V_{t+1}(x_{t+1}, r_{t+1})$ is decreasing in r_{t+1} then $r_{t+1} = \theta r_t + (1-\theta)x_t$ implies $V_{t+1}(x_{t+1}, r_{t+1})$ is decreasing in r_t, which in turn means that $V_t(x_t, r_t) = \max\{-c_t + m(x_t - r_t) + \mathbb{E}V_{t+1}(x_{t+1}, r_{t+1}), m(x_t - r_t) - A - B\sum_{i=1}^{t-1} c_i\}$ is decreasing in r_t. It follows that

$U_t^{\mathrm{C}}(x_t, r_t) - U_t^{\mathrm{A}}(x_t, r_t) = -c + \mathbb{E}V_{t+1}(x_{t+1}, r_{t+1}) + A + B\sum_{i=1}^{t-1} c_i$ is decreasing in r_t. This completes the proof. ■

Proof of Result 1. Since the PM abandons the project if and only if $U_3^{\mathrm{C}}(x_3, r_3) < U_3^{\mathrm{A}}(x_3, r_3)$, it suffices to prove that $U_3^{\mathrm{C}}(x_3, r_3) - U_3^{\mathrm{A}}(x_3, r_3)$ is smaller under LR than under FR. For the PM, the marginal utility from continuing the project at stage 3 is

$$U_3^{\mathrm{C}}(x_3, r_3) - U_3^{\mathrm{A}}(x_3, r_3) = x_3 - c_3 + \frac{1}{2}m(\theta(x_3 - r_3) + \delta) + \frac{1}{2}m(\theta(x_3 - r_3) - \delta) + A + B(c_1 + c_2). \quad \text{(EC.2)}$$

Because $x_3 < x_1$ implies that the project's performance consistently decreases from stage 1 to stage 3, i.e., $x_2 = x_1 - \delta$ and $x_3 = x_1 - 2\delta$, we can derive $r_3 = x_1 - (1-\theta)\delta$ under FR and $r_3 = x_1$ under LR. Observe that the right hand side of equation (EC.2) is decreasing in r_3, and r_3 is higher under LR than under FR, it follows that $U_3^{\mathrm{C}}(x_3, r_3) - U_3^{\mathrm{A}}(x_3, r_3)$ is smaller under LR than under FR. ■

Proof of Result 2. For the PM under LR, the marginal utility of continuation at $x_2 = x_1 - \delta$ is

$$\begin{aligned}\Delta_2^{\mathrm{LR}} \equiv U_2^{\mathrm{C}}(x_2, r_2, 2, 0) - U_2^{\mathrm{A}}(x_2, r_2, 2, 0) &= x_2 - c_2 - c_3 + \mathbb{E}V_4(x_4, r_4, 2, 0)\\ &= x_2 - c_2 - c_3 + \frac{1}{4}m(-\theta\delta + 2\delta) + \frac{1}{2}m(-\theta\delta) + \frac{1}{4}m(-\theta\delta - 2\delta) + A + Bc_1.\end{aligned} \quad \text{(EC.3)}$$

In contrast, for the PM under FR, the marginal utility of continuation at $x_2 = x_1 - \delta$ is

$$\begin{aligned}\Delta_2^{\mathrm{FR}} &\equiv U_2^{\mathrm{C}}(x_2, r_2) - U_2^{\mathrm{A}}(x_2, r_2) = -c_2 + \mathbb{E}V_3(x_3, r_3) + A + Bc_1\\ &= -c_2 + \frac{1}{2}\max\{U_3^{\mathrm{C}}(x_2 - \delta, r_3), U_3^{\mathrm{A}}(x_2 - \delta, r_3)\} + \frac{1}{2}\max\{U_3^{\mathrm{C}}(x_2 + \delta, r_3), U_3^{\mathrm{A}}(x_2 + \delta, r_3)\} + A + Bc_1\\ &\geq -c_2 + \frac{1}{2}U_3^{\mathrm{C}}(x_2 - \delta, r_3) + \frac{1}{2}U_3^{\mathrm{C}}(x_2 + \delta, r_3) + A + Bc_1\\ &= x_2 - c_2 - c_3 + \frac{1}{2}m(-\theta\delta + \delta) + \frac{1}{2}m(-\theta\delta - \delta) + \frac{1}{4}m(-\theta^2\delta + \theta\delta + \delta) + \frac{1}{4}m(-\theta^2\delta + \theta\delta - \delta)\\ &\quad + \frac{1}{4}m(-\theta^2\delta - \theta\delta + \delta) + \frac{1}{4}m(-\theta^2\delta - \theta\delta - \delta) + A + Bc_1.\end{aligned} \quad \text{(EC.4)}$$

Subtracting (EC.3) from (EC.4), we have

$$\begin{aligned}\Delta_2^{FR} - \Delta_2^{LR} \geq &\frac{1}{2}m(-\theta\delta + \delta) + \frac{1}{2}m(-\theta\delta - \delta) + \frac{1}{4}m(-\theta^2\delta + \theta\delta + \delta) + \frac{1}{4}m(-\theta^2\delta + \theta\delta - \delta)\\ &+ \frac{1}{4}m(-\theta^2\delta - \theta\delta + \delta) + \frac{1}{4}m(-\theta^2\delta - \theta\delta - \delta) - \frac{1}{4}m(-\theta\delta + 2\delta) - \frac{1}{2}m(-\theta\delta) - \frac{1}{4}m(-\theta\delta - 2\delta).\end{aligned} \quad \text{(EC.5)}$$

We proceed to prove a threshold $\bar{\lambda}$ such that if $\lambda < \bar{\lambda}$, then the right hand side of (EC.5) is positive. We consider two cases. (I) If $1 - \theta - \theta^2 \geq 0$, then the right hand side of (EC.5) equals $\frac{\gamma}{4}(2 - \theta - 2\theta^2)\delta - \frac{\gamma\lambda}{4}(2 - \theta + 2\theta^2)\delta$, which is positive if and only if $\lambda < \frac{2-\theta-2\theta^2}{2-\theta+2\theta^2}$. (II) If $1 - \theta - \theta^2 < 0$, then the right hand side of (EC.5) equals $\frac{\gamma}{4}(1 - \theta^2) - \frac{\gamma\lambda}{4}(1 + 3\theta^2)$, which is positive if and only if $\lambda < \frac{1-\theta^2}{1+3\theta^2}$. This completes the proof. ■

Proof of Proposition EC.1. The statement in the proposition is equivalent to: Given the project value x_t in stage $t = 1, \ldots, T-2$, if it is optimal to abandon either at $x_{t+1} = x_t - \delta$ or at $x_{t+1} = x_t + \delta$ in stage $t+1$, then it is optimal to abandon in stage t. We prove this in two possible cases.

Case 1: Suppose it is optimal in stage $t+1$ to abandon at both $x_{t+1} = x_t + \delta$ and $x_{t+1} = x_t - \delta$. This implies zero value for the project in stage $t+1$ (i.e., $\mathbb{E}[V_{t+1}(x_t + w_t) \mid x_t] = 0$) and hence zero value for the project at stage t (i.e., $V_t(x_t) = \max\{-c_t + \mathbb{E}[V_{t+1}(x_t + w_t)], 0\} = \max\{-c_t, 0\} = 0$). Therefore, it is optimal to abandon the project at stage t.

Case 2: Suppose it is optimal in stage $t+1$ to abandon at $x_{t+1} = x_t - \delta$ but to continue at $x_{t+1} = x_t + \delta$. In this case, we prove the result by induction.

First, we prove the result for $t = T-2$. Thus: given x_{T-2} in stage $T-2$, if it is optimal in stage $T-1$ to abandon the project at $x_{T-1} = x_{T-2} - \delta$ but to continue at $x_{T-1} = x_{T-2} + \delta$, then it is optimal to abandon in stage $T-2$. Observe that $x_{T-2} - \delta - c \leq 0$ and $\delta \leq c$. The first inequality follows because (a) the PM abandons the project at $x_{T-1} = x_{T-2} - \delta$ and (b) it is optimal to abandon in stage $T-1$ if and only if $x_{T-1} \leq c$. The inequality $\delta \leq c$ holds because project payoffs are non-negative—that is, $x_{T-2} - 2\delta \geq 0$—and this (when combined with the first inequality) yields $x_{T-2} - \delta - c \leq 0 \leq x_{T-2} - 2\delta$ or $c \geq \delta$. These two inequalities together imply that $V_{T-2}(x_{T-2}) = \max\{-c + \frac{1}{2}(x_{T-2} + \delta - c), 0\} = \max\{\frac{1}{2}(x_{T-2} - \delta - c + 2\delta - 2c), 0\} = 0$.

Second, we prove that if the result holds at stage $k+1$ ($k = 1, \ldots, T-3$) then it holds also at stage k. If the result holds at stage $k+1, \ldots, T-2$, then $V_{k+1}(x) = \max\{x - (T-k-1)c, 0\}$; that is, at stage $k+1$ the PM either abandons the project or continues until completion. From the conditions $V_{k+1}(x_k + \delta) > 0$ and $V_{k+1}(x_k - \delta) = 0$ we then have

$$V_k(x_k) = \max\left\{ -c + \frac{1}{2}(x_k + \delta - (T-k-1)c), 0\right\} = \max\left\{\frac{1}{2}(x_k - \delta - (T-k-1)c + 2\delta - 2c), 0\right\} = 0,$$

which follows from (i) $x_k - \delta - (T-k-1)c \leq 0$ and (ii) $\delta \leq c$. Inequality (i) follows from $x_k - \delta - (T-k-1)c \leq V_{t+1}(x_k - \delta) = 0$; this statement holds because, at $x_{k+1} = x_k - \delta$, the expected profit from completing the project (i.e., $x_k - \delta - (T-k-1)c$) is by definition no greater than the project's value $V_{t+1}(x_k - \delta)$. Inequality (ii) follows because project payoffs are nonnegative (i.e., $x_k \geq (T-k)\delta$), which—together with inequality (i)—implies $(T-k-1)\delta \leq x_k - \delta \leq (T-k-1)c$. This completes the proof. ■

Proof of Corollary EC.1. This result follows directly from Lemma 1 and Proposition EC.1. ■

Proof of Corollary EC.2. We denote the expected profits from continuing the project under FR and LR as $\Pi^{\mathrm{C}}_{t,\mathrm{FR}}(x_t)$ and $\Pi^{\mathrm{C}}_{t,\mathrm{LR}}(x_t, t, n)$, respectively. First, at x_t, if the optimal decision in FR is to abandon the project (i.e., $\Pi^{\mathrm{C}}_{t,\mathrm{FR}}(x_t) \leq 0$) then the optimal decision in LR is also to abandon the project because $\Pi^{\mathrm{C}}_{t,\mathrm{LR}}(x_t, t, n) \leq \Pi^{\mathrm{C}}_{t,\mathrm{FR}}(x_t) \leq 0$, where the first inequality holds because FR has no fewer review opportunities than does LR. Next, at x_t, if the optimal decision in FR is to continue the project (i.e., $\Pi^{\mathrm{C}}_{t,\mathrm{FR}}(x_t) = x_t - (T-t)c > 0$; see Proposition EC.1), then the optimal decision in LR is also to continue the project because $\Pi^{\mathrm{C}}_{t,\mathrm{LR}}(x_t, t, n) \geq x_t - (T-t)c$—that is, the expected profit from continuing the project is no less than that from project completion. ■

Online Appendix D: Experiment Instructions and Sample Screenshots

On-line Game

Instructions

This is an experiment about economic decision-making. The instructions are simple, and if you follow them carefully and make appropriate decisions, you may earn a considerable amount of money which will be paid to you in cash at the end of the experiment. It is important that you do not look at the decisions of others, and that you do not talk, laugh, or make noises during the experiment. You will be warned if you violate this rule the first time. If you violate this rule twice, you will be asked to leave the room immediately and your cash earnings will be 0.

In this study, you will play the role of an investor who is responsible for investing in the development of a project. At each development stage, you will receive information about the market value of the project upon completion. This value will change over time because there are technical and market uncertainties in the development process. For instance, the value may increase if there has been a technical breakthrough, and decrease if new technical assessment tests yield poor results. At each stage, you will observe this change and, based on this information, you must decide whether to continue investing in the project, or abandon the project. If you continue the project until completion, then you will gain its market value that will be realized upon completion. On the other hand, if you abandon the project early, the market value of the project will not be materialized and your payoff will be zero. The money you have invested in project cannot be recuperated. There will be 32 projects in total. Each project is different and independent from the others. You will work on a new one once you complete or abandon your current one. The detailed experimental procedure is described below.

Experimental Procedure

Each project consists of *T* stages. Stages *1,...,T-1* are development stages. At each development stage, you must make the following decision(s).

<u>1) You receive information about the market value of the project.</u>

You will observe a value (VALUE) that represents the current estimate of the market value of the project upon completion. VALUE changes over time as technical uncertainties in the project are resolved. Specifically, if you continue the project in the current stage, then in the next stage VALUE may increase or decrease by *10* with equal chance. Note that the amount by which VALUE changes does not depend on previous stages. For example, if VALUE is x_t at stage *t* and you continue the project, then VALUE at stage *t+1* will be either $x_t + 10$ or $x_t - 10$.

<u>2) You decide whether to continue or abandon the project.</u>

After knowing the value, if you decide to abandon the project, you will not have to pay any further cost, but you will not get any payoff from the project either. If you decide to continue the project, then you will pay continuation cost *11*, and move on to the next stage.

Figure 1 illustrates the decision and possible values in the next stage under continuation at development stage *t*.

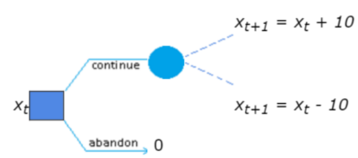


Figure 1

If you continue the project until stage *T*, then the VALUE of the project at stage *T* becomes your PAYOFF of this completed project. Figure 2 illustrates that if at stage *T-1* the project is continued, then the value at the stage *T*, x_T will become the payoff of this project.

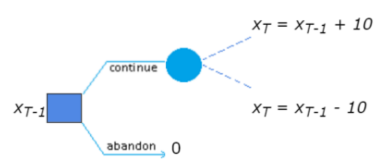


Figure 2

You will be given a new project once the current one is abandoned or completed. Before each project starts, you will learn the number of stages in this project (*T*) and initial VALUE (x_1). In the projects you will be given, *T* ranges from 4 to 10.

Point Earnings

Your point earning from each project equals:

PAYOFF-TOTAL COST

1) If you continue the project until stage T, your PAYOFF is x_T, and your TOTAL COST is $(T-1)*11$. Your point earning in this case is $x_T - (T-1)*11$;

2) If you abandon your project before stage T, your PAYOFF is 0. TOTAL COST is the sum of the continuation costs. Therefore, if you abandoned the project at stage t, then your point earning equals $0 - (t-1)*11$.

Your Dollar Payoffs

At the end of the experiment, we will sum your point earning in each round to obtain your total point earning. We will then multiply your total point earning by 0.075 to obtain your dollar earning. In addition, we will add to this dollar earning $5 show-up fee to determine your final dollar earning. The amount will be paid to you in cash before you leave the experiment today.

Check your understanding

To check whether the above instructions are clear enough and understandable, we ask you to do the following exercises. We will start the real experiment once you complete all questions correctly.

1) Suppose $T = 6$, $x_1 = 50$. If you abandon the project at stage 4, your point earnings for this project is [ ].

2) Suppose at the current stage you observe that the VALUE of the project is y, and you continue, then the next stage the VALUE of the project will be [ ] or [ ].

3) Suppose $T = 10$, $x_1 = 90$. If you continue the project to completion and $x_{10} = 120$, your point earnings for this project is [ ].

CONTINUE

Instructions

This is an experiment about economic decision-making. The instructions are simple, and if you follow them carefully and make appropriate decisions, you may earn a considerable amount of money which will be paid to you in cash at the end of the experiment. It is important that you do not look at the decisions of others, and that you do not talk, laugh, or make noises during the experiment. You will be warned if you violate this rule the first time. If you violate this rule twice, you will be asked to leave the room immediately and your cash earnings will be 0.

In this study, you will play the role of an investor who is responsible for investing in the development of a project. The estimated market value of the project will change over time because there are technical and market uncertainties in the development process. For instance, the value may increase if there has been a technical breakthrough, and decrease if new technical assessment tests yield poor results. At each development stage, you must decide whether to review the project. If you review, you will observe the current estimate of the project's market value upon completion. Based on this information, you can decide whether to continue investing in the project, or abandon the project. If you choose not to review, then you will not receive any information and the project will be continued automatically until the next stage. If you continue investing in the project until completion, then you will gain its market value that will be realized upon completion. On the other hand, if you abandon the project early, the market value of the project will not be materialized and your payoff will be zero. The money you have invested in the project cannot be recuperated. There will be 32 projects in total. Each project is different and independent from the others. You will work on a new one once you complete or abandon your current one. The detailed experimental procedure is described below.

Experimental Procedure

Each project consists of *T* stages. Stages *1,...,T-1* are development stages. At each development stage, you must make the following decision(s).

<u>You decide whether to review the project.</u>

The cost of review is zero. *However, you can only review the project up to k times.* After *k* reviews, the project will either continue until completion (stage *T*) or stop, depending on your decision in the last review. You do not have to use all the reviews. Reviewing in stage 1 is automatic and does not count against the quota.

1) If you do not review the project: the project will be automatically continued. You will pay continuation cost *11*, and move on to the next stage.

2) If you do review the project:

<u>2a) You receive information about the market value of the project.</u>

You will observe a value (VALUE) that represents the current estimate of the market value of the project upon completion. VALUE changes over time as technical uncertainties in the project are resolved. Specifically, if you continue the project in the current stage, then in the next stage VALUE will increase or decrease by 10 with equal chance. Note that the amount by which VALUE changes per stage does not depend on previous stages, nor does it depend on your review decisions. For example, if VALUE at stage t is x_t, then VALUE at stage $t + 1$ will be $x_{t+1} = x_t + 10$ or $x_{t+1} = x_t - 10$ with equal chance, VALUE at stage $t + 2$ will be $x_{t+1} + 10$ or $x_{t+1} - 10$ with equal chance, and so on. Reviewing the project simply reveals the VALUE in the current stage to you. If you review the project at stage t, observe VALUE is x_t, and do not review until $t + j$, then VALUE at stage $t + j$ is the sum of x_t and j changes, where each change is an increase or decrease of *10* with equal chance.

Figure 1 illustrates the possible values in stage $t + 3$ (and corresponding path history) if you review and continue the project at development stage t, and then do not review until stage $t + 3$.

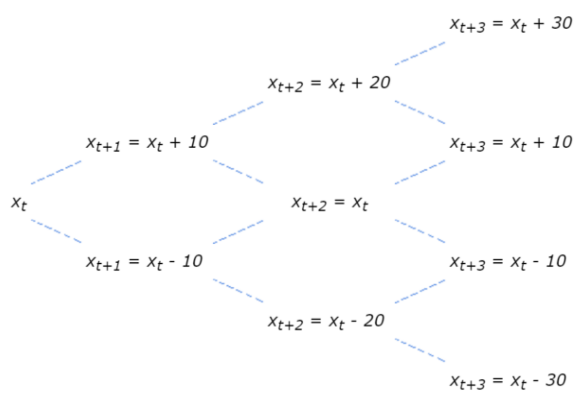


Figure 1

2b) You decide whether to continue or abandon the project.

After reviewing the project and knowing the value, if you decide to abandon the project, you will not have to pay any further cost, but you will not get any payoff from the project either. If you decide to continue the project, then you will pay continuation cost *11*, and move on to the next stage.

Figure 2 illustrates the decisions and possible values in stage $t + 1$ under continuation at development stage t.

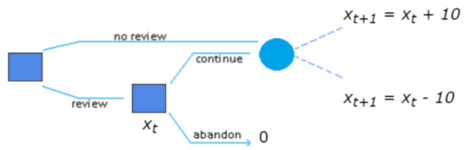


Figure 2

If you continue the project until stage T, then the VALUE of the project at stage T becomes your PAYOFF of this completed project. Figure 3 illustrates that if at stage T-*1* the project is continued, then the value at the stage T, x_T will become the payoff of this project.

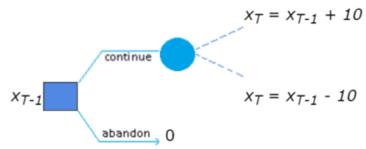


Figure 3

You will be given a new project once the current one is abandoned or completed. Before each project starts, you will learn the number of stages in this project (T) and initial VALUE (x_1) and the number of reviews allowed (k). In the projects you will be given, T ranges from 4 to 10.

Point Earnings

Your point earning from each project equals:

PAYOFF-TOTAL COST

1) If you continue the project until stage T, your PAYOFF is x_T, and your TOTAL COST is $(T-1)*11$. Your point earning in this case is $x_T - (T-1)*11$;

2) If you abandon your project before stage T, your PAYOFF is 0. TOTAL COST is the sum of the continuation costs. Therefore, if you abandoned the project at stage t, then your point earning equals $0 - (t-1)*11$.

Your Dollar Payoffs

At the end of the experiment, we will sum your point earning in each round to obtain your total point earning. We will then multiply your total point earning by 0.075 to obtain your dollar earning. In addition, we will add to this dollar earning $5 show-up fee to determine your final dollar earning. The amount will be paid to you in cash before you leave the experiment today.

Check your understanding

To check whether the above instructions are clear enough and understandable, we ask you to do the following exercises. We will start the real experiment once you complete all questions correctly.

1) TRUE or FALSE: at any development stage, the cost you have to pay to continue the project until the next stage is the same whether you review or not. ○ True ○ False

2) Suppose $T = 6$, $x_1 = 50$. If you abandon the project at stage 4, your point earnings for this project is [ ].

3) Suppose at the current stage (t) you observe that the VALUE of the project is y. You continue and review again after two stages (at $t+2$), then you will observe the VALUE of the project to be at best [ ] and at worst [ ].

4) Suppose $T = 10$, $x_1 = 90$. If you continue the project to completion and $x_{10} = 120$, your point earnings for this project is [ ] .

CONTINUE

On-line Game

Instructions

Starting Project 1 of 32

Project's initial value:	**30**
Total number of stages:	**4**
Change per stage:	10
Continuation cost:	11

Click on the Continue button to proceed to Stage 1.

CONTINUE

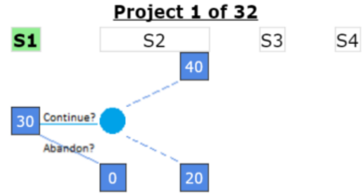
You are logged in as exp_1_30.

On-line Game

Instructions

Project's Initial Value	Current Stage
30	1
Number of Stages	Current total cost
4	0
Change per stage	Current Project Value
10	30
Continuation cost	
11	

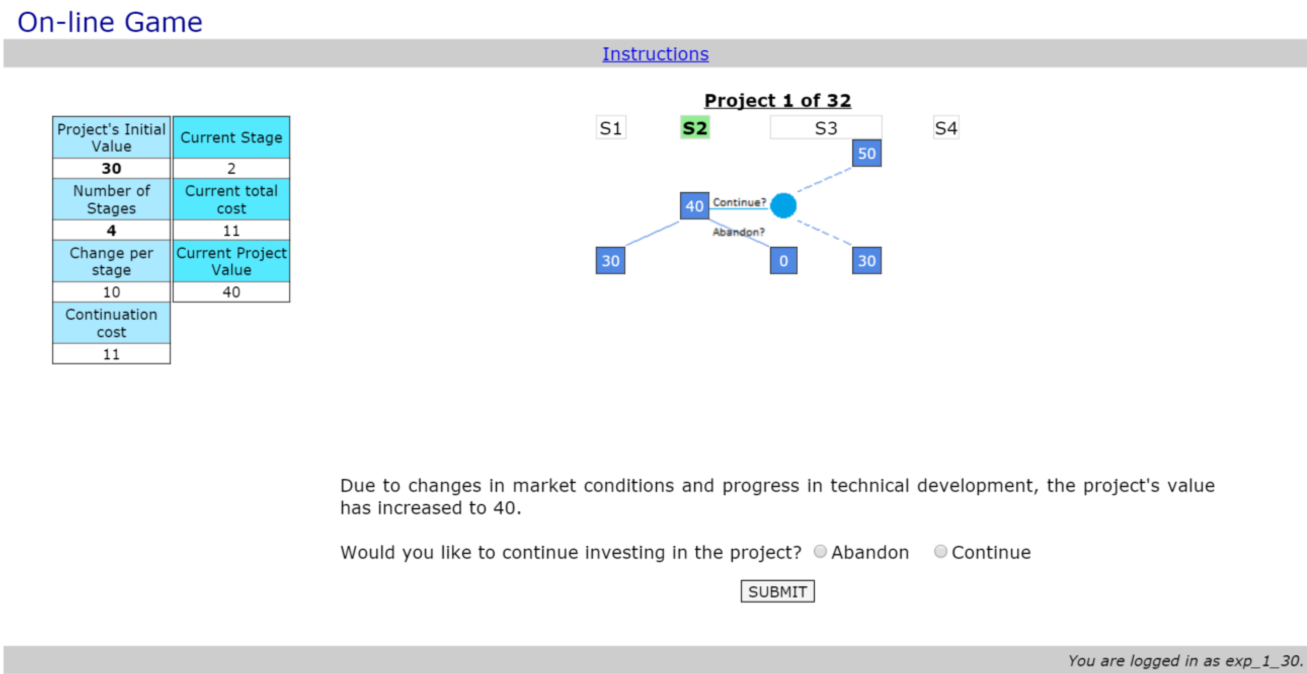
Project 1 of 32

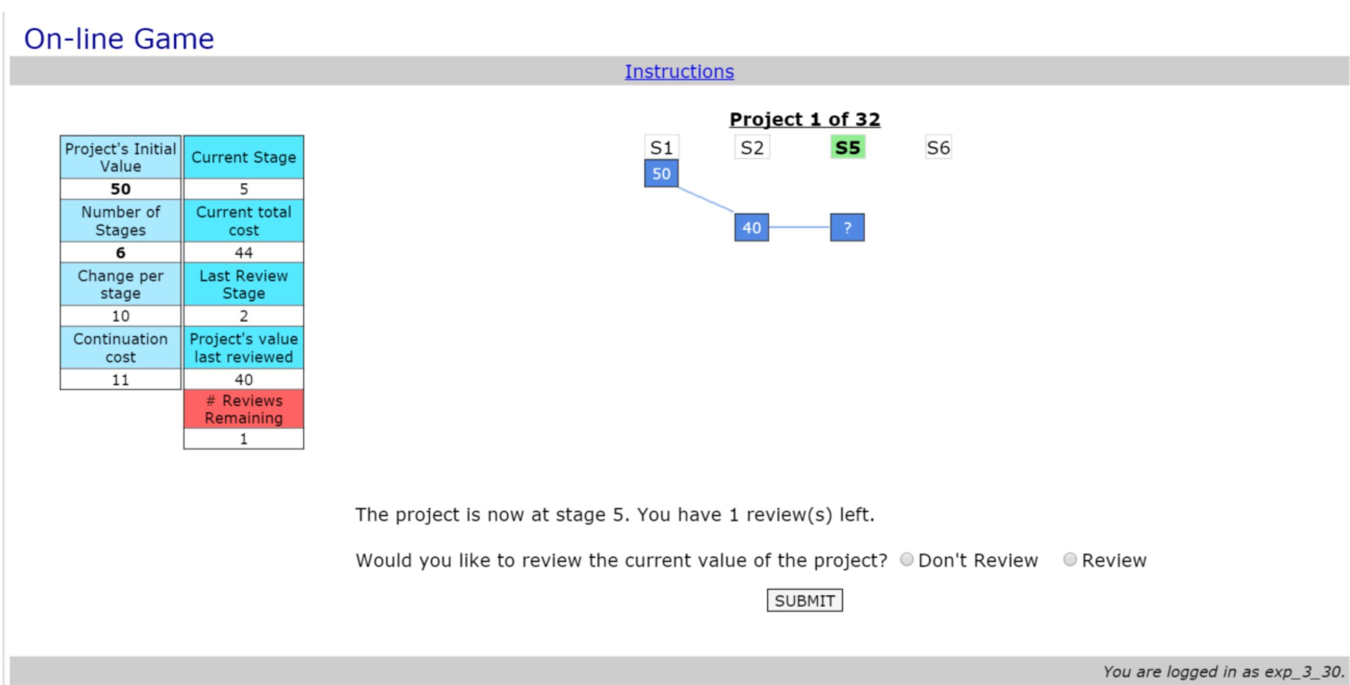


Would you like to continue investing in the project? Abandon Continue

SUBMIT

You are logged in as exp_1_30.


On-line Game
Instructions
Project 1 of 32
S1
S2
S3
S4
50
40
Continue?
Abandon?
30
0
30
Project's Initial Value
30
Current Stage
2
Number of Stages
4
Current total cost
11
Change per stage
10
Current Project Value
40
Continuation cost
11
Due to changes in market conditions and progress in technical development, the project's value has increased to 40.
Would you like to continue investing in the project? Abandon Continue
SUBMIT
You are logged in as exp_1_30.


On-line Game
Instructions
Project 1 of 32
S1
S2
S5
S6
50
40
?
Project's Initial Value
50
Current Stage
5
Number of Stages
6
Current total cost
44
Change per stage
10
Last Review Stage
2
Continuation cost
11
Project's value last reviewed
40
Reviews Remaining
1
The project is now at stage 5. You have 1 review(s) left.
Would you like to review the current value of the project? Don't Review Review
SUBMIT
You are logged in as exp_3_30.

Online Appendix E: Regression Results

This appendix documents the regression results mentioned in the paper.

Table 1: Logistic regression model for continue decision with different paths of same length (Section 4.2)

Independent variable	Coefficient	Robust std. error
decpath	-2.397^{***}	(0.485)
(t=2)×(T=6)	1.156	(0.843)
(t=2)×(T=8)	0.285	(0.957)
(t=3)×(T=6)	0.341	(0.737)
(t=3)×(T=8)	-1.218^{*}	(0.715)
(t=4)×(T=6)	-0.636	(0.540)
(t=4)×(T=8)	-0.671	(0.560)
(t=5)×(T=8)	-1.336^{*}	(0.776)
Constant	5.034^{***}	(0.747)
Observations	827	
Clusters	37	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Logistic regression model for continue decision with different project lengths (Section 4.2)

Independent variable	Coefficient	Robust std. error
mid	-0.706^{**}	(0.298)
prof	1.788^{**}	(0.769)
stageleft=2	-1.212	(1.102)
stageleft=3	-1.538	(1.106)
stageleft=4	-1.023	(0.984)
stageleft=5	-1.083	(1.074)
stageleft=6	-1.059	(1.124)
stageleft=7	-1.191	(1.048)
stageleft=8	-0.803	(1.197)
stageleft=9	-1.516	(1.153)
(prof=1)×(stageleft=2)	-1.237	(0.904)
(prof=1)×(stageleft=3)	-0.857	(0.800)
(prof=1)×(stageleft=4)	-1.291	(0.851)
(prof=1)×(stageleft=5)	-1.505^{*}	(0.776)
(prof=1)×(stageleft=6)	-1.296	(1.046)
Constant	3.401^{***}	(1.031)
Observations	2483	
Clusters	37	

Notes. We use the binary variable 'prof' which interacts with the number of stages left as a proxy for project value.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Logistic regression model for continue decision in FR vs. LR experiment (Section 5.1)

	Model 1 (excluding stage 1)		Model 2 (including stage 1)	
Independent variable	Coefficient	Robust std. error	Coefficient	Robust std. error
FR	0.958***	(0.262)	0.147	(0.250)
stageleft=2	−1.104*	(0.645)	−1.136*	(0.634)
stageleft=3	−1.387**	(0.614)	−0.944	(0.625)
stageleft=4	−0.743	(0.580)	−0.787	(0.579)
stageleft=5	−1.399**	(0.591)	−0.653	(0.614)
stageleft=6	−1.006	(0.645)	−0.962	(0.640)
stageleft=7	−1.067*	(0.595)	−0.408	(0.625)
stageleft=8	−0.400	(0.725)	−0.318	(0.720)
stageleft=9			−0.330	(0.724)
Constant	2.028***	(0.595)	2.513***	(0.615)
Observations	1427		3302	
Clusters	75		75	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Ordered logistic regression model for interval between the first and second review (Section 5.2)

	Model 1 (unprofitable projects)		Model 2 (all projects)	
Independent variable	Coefficient	Robust std. error	Coefficient	Robust std. error
r1sign	−0.952***	(0.161)	−0.882***	(0.148)
cut1	−1.005***	(0.186)	−0.977***	(0.189)
cut2	0.413***	(0.144)	0.516***	(0.136)
cut3	1.997***	(0.222)	2.166***	(0.210)
cut4	3.809***	(0.528)	4.035***	(0.524)
cut5	4.171***	(0.732)	4.396***	(0.729)
cut6	5.432***	(0.992)	5.655***	(0.990)
Observations	615		784	
Clusters	38		38	

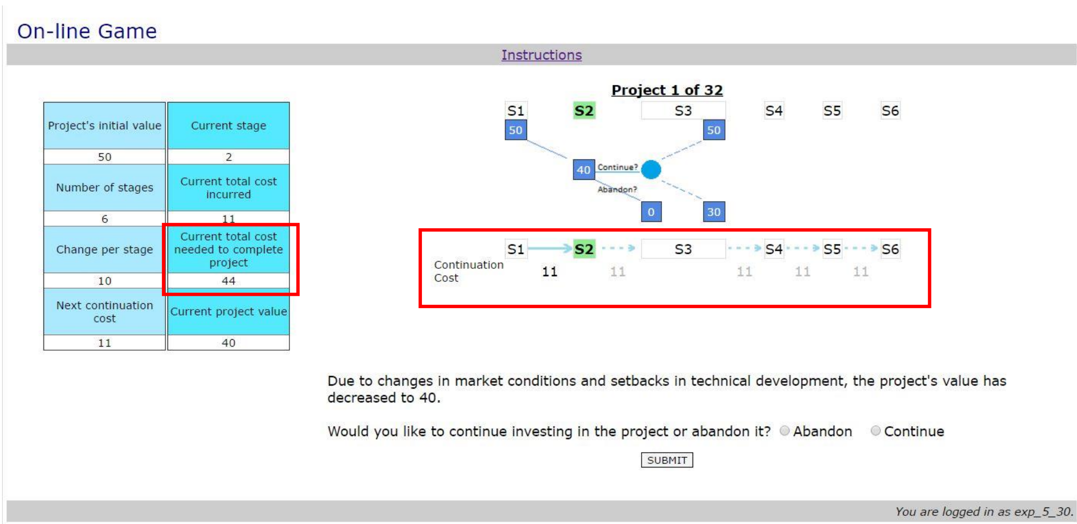
Notes. Project that are abandoned upon first review are excluded. If the project is continued and no second review is undertaken, then the second review stage is set equal to the stage of project completion (T).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Online Appendix F: Robustness Check with Cost Saliency

In this appendix we discuss the treatment with salient cost. First we detail the changes in the experiment setup, and then compare the new results with those from the original experiments. Finally, we present the data and regression results.

We made the following changes in the new experiment.

First, on the interface, we added (1) a graphic illustration of future and past costs, and (2) a box on the left side of the screen which provided information about "current total cost needed to complete project". This information was observable to participants at every decision stage of the experiment. Below is a sample screenshot of the new interface (changes are highlighted in red boxes).

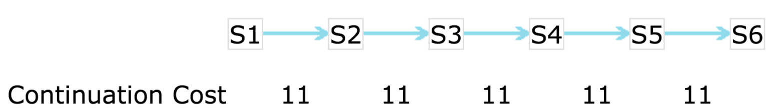


Second, we revised the instructions to emphasize cost as well as value. We made the following edits to the instructions:

(1) We replaced 'VALUE' with 'the value' throughout the instructions.

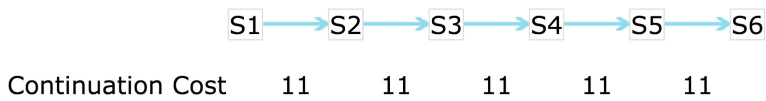
(2) In "Check your understanding", we added illustrations of project costs to Question 1 in FR and Question 2 in LR. The question now appears as follows:

> "Suppose $T = 6$, $x_1 = 50$. Continuation costs are illustrated in the figure below. If you abandon the project at stage 4, your point earning for this project is ______."



(3) In "Check your understanding", we changed the last question (Question 3 in FR and Question 4 in LR) to ask directly about the total cost needed to complete a project and also provided an illustration of project costs. The question now reads as follows:

"Suppose $T = 6$, $x_1 = 50$. Continuation costs are illustrated in the figure below. If you continue the project at every stage until stage 6: the total cost incurred will be ______, the value of the project (x_6) will be at best ______ and at worst ______, your point earning for this project will be at best ______ and at worst ______."



We ran the new experiments in the same venue as the original experiments, and recruited 81 undergraduate students who had not participated in the original experiments. Overall, 43 subjects participated in the new FR experiment and 38 subjects in the new LR experiment.

Comparison with Original Experiments

We find that most of the key results from the original experiments remain the same. In particular, participants are more likely to abandon on downward paths, and are more likely to abandon when review opportunities are limited. Tables 6–12 present the new data and replications of all regression results in the original experiments. Below we discuss one difference in experimental results based on the new data and original data.

In the new FR data, we do not observe a consistent inverted U-shaped effect of project length on abandonment rates (see Figure 2). This could be due to two reasons. First, salient cost has a disproportionate effect on abandonment rates in the first stage versus later stages. That is, comparing the continuation error rates in the original and new FR data (see Table 5), we find a significant difference in the first stage (75.8% vs. 87.7%; $p < 0.01$) but not in later stages (90.12% vs. 87.85%, $p = 0.16$). This suggests that FR participants employ different decision processes for launch and continue/abandon decisions under salient cost. In deciding whether to launch a project in the first stage, FR participants may compare its expected value with the total cost of completing the project, but once a project is started, the behavioral biases to continue the project dominate. As a result, we observe higher abandonment rates at the beginning of a project.

Table 5: Continuation error rates

	New	Original
Stage 1	75.8% ($N = 1{,}075$)	87.7% ($N = 925$)
All stages except stage 1	90.12% ($N = 992$)	87.85% ($N = 963$)

Notes. N = number of observations.

Second, recall that in the original experiments we provide information about *total cost incurred* but not *total cost needed to complete the project*. Adding the latter makes future cost more salient, which counteracts the participants' sunk cost biases and thus weakens the pattern of lower abandonment rates towards a project's end. Despite these differences, we still observe significant evidence of a higher abandonment rate near the middle of an ongoing project in some cases. For example, at the decision point $x_{T-3} = 30$, the abandonment rate is significantly higher at stage 3 of a 6-stage project than at stage 7 of a 10-stage project ($p < 0.05$); at $x_{T-6} = 60$, the abandonment rate is significantly lower at stage 2 of an 8-stage project than at stage 4 of a 10-stage project ($p < 0.01$).

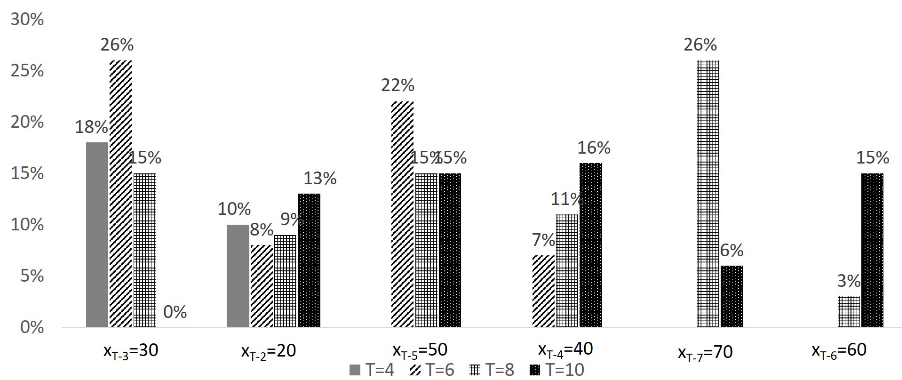


Figure 2: Proportion of abandonment in project on a decreasing-value path; T represents the total number of project stages.

Table 6: Abandonment rates corresponding to different paths.

	Strictly decreasing path?			Strictly decreasing path?	
	Yes	No		Yes	No
$T = 4$			$T = 8$		
$x_2 = 40$	3%	0%	$x_2 = 80$	2%	0%
	$(N = 40)$	$(N = 105)$		$(N = 84)$	$(N = 62)$
$T = 6$			$x_3 = 70$	2%	3%
$x_2 = 60$	2%	0%		$(N = 82)$	$(N = 32)$
	$(N = 42)$	$(N = 98)$	$x_4 = 60$	13%	0%
$x_3 = 50$	7%	0%		$(N = 39)$	$(N = 26)$
	$(N = 41)$	$(N = 62)$	$x_5 = 50$	6%	0%
$x_4 = 40$	13%	0%		$(N = 34)$	$(N = 21)$
	$(N = 38)$	$(N = 87)$			

Table 7: Abandonment rates—under FR versus LR—when the optimal decision is to abandon.

	Abandonment rate			Abandonment rate			Abandonment rate	
	FR	LR		FR	LR		FR	LR
$T = 4$			$T = 8$			$T = 10$		
$x_1 = 30$	18%	15%	$x_1 = 70$	26%	14%	$x_1 = 90$	30%	21%
	$(N = 258)$	$(N = 228)$		$(N = 215)$	$(N = 190)$		$(N = 344)$	$(N = 304)$
$x_2 = 20$	10%	43%	$x_2 = 60$	3%	24%	$x_2 = 80$	2%	7%
	$(N = 107)$	$(N = 63)$		$(N = 97)$	$(N = 21)$		$(N = 121)$	$(N = 27)$
$x_3 = 10$	12%	15%	$x_3 = 50$	15%	40%	$x_3 = 70$	6%	33%
	$(N = 34)$	$(N = 13)$		$(N = 94)$	$(N = 52)$		$(N = 88)$	$(N = 40)$
			$x_4 = 40$	11%	45%	$x_4 = 60$	15%	52%
$T = 6$				$(N = 54)$	$(N = 29)$		$(N = 55)$	$(N = 25)$
$x_1 = 50$	22%	16%	$x_5 = 30$	15%	57%	$x_5 = 50$	15%	44%
	$(N = 258)$	$(N = 228)$		$(N = 27)$	$(N = 7)$		$(N = 47)$	$(N = 16)$
$x_2 = 40$	7%	29%	$x_6 = 20$	9%	0%	$x_6 = 40$	16%	43%
	$(N = 104)$	$(N = 31)$		$(N = 23)$	$(N = 3)$		$(N = 19)$	$(N = 7)$
$x_3 = 30$	26%	35%				$x_7 = 30$	0%	50%
	$(N = 66)$	$(N = 52)$					$(N = 16)$	$(N = 2)$
$x_4 = 20$	8%	42%				$x_8 = 20$	13%	100%
	$(N = 24)$	$(N = 12)$					$(N = 16)$	$(N = 1)$

Table 8: Proportion of first review by stage.

Project length and initial value	N	Proportion of first review decision: Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9
$T = 4$									
$x_1 = 30$	193	65%	31%						
$x_1 = 50$	74	54%	41%						
$T = 6$									
$x_1 = 50$	192	43%	49%	4%	1%				
$x_1 = 70$	73	40%	53%	7%	1%				
$T = 8$									
$x_1 = 70$	163	25%	44%	26%	4%	0%	0%		
$x_1 = 90$	107	29%	36%	28%	4%	1%	0%		
$T = 10$									
$x_1 = 90$	241	20%	27%	31%	15%	3%	1%	0%	0%

Table 9: Logistic regression model for continue decision with different paths of same length

Independent variable	Coefficient	Robust std. error
decpath	-3.360^{***}	(1.013)
(t=2)×(T=6)	0.040	(0.049)
(t=2)×(T=8)	−0.015	(0.783)
(t=3)×(T=6)	−1.157	(1.192)
(t=3)×(T=8)	−0.470	(1.224)
(t=4)×(T=6)	−1.769	(1.128)
(t=4)×(T=8)	−1.808	(1.137)
(t=5)×(T=8)	−0.958	(1.268)
Constant	7.115^{***}	(1.212)
Observations	893	
Clusters	43	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Logistic regression model for continue decision with different project lengths

Independent variable	Coefficient	Robust std. error
mid	0.108	(0.288)
prof	2.804^{***}	(0.788)
stageleft=2	0.168	(0.630)
stageleft=3	−0.543	(0.617)
stageleft=4	0.262	(0.668)
stageleft=5	−0.622	(0.626)
stageleft=6	0.498	(0.667)
stageleft=7	−0.668	(0.633)
stageleft=8	1.657^{**}	(0.815)
stageleft=9	-1.151^{*}	(0.601)
(prof=1)×(stageleft=2)	-2.553^{***}	(0.905)
(prof=1)×(stageleft=3)	-1.611^{**}	(0.724)
(prof=1)×(stageleft=4)	-2.606^{***}	(0.882)
(prof=1)×(stageleft=5)	−0.241	(0.950)
(prof=1)×(stageleft=6)	−1.603	(1.053)
Constant	2.015^{***}	(0.539)
Observations	2768	
Clusters	43	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Logistic regression model for continue decision in FR vs. LR experiment

	Model 1 (excluding stage 1)		Model 2 (including stage 1)	
Independent variable	Coefficient	Robust std. error	Coefficient	Robust std. error
FR?	1.581***	(0.280)	0.257	(0.236)
stageleft=2	−0.514	(0.526)	−0.531	(0.483)
stageleft=3	−0.806	(0.527)	−0.433	(0.483)
stageleft=4	−0.355	(0.552)	−0.323	(0.507)
stageleft=5	−0.720	(0.494)	−0.515	(0.476)
stageleft=6	−0.261	(0.571)	−0.171	(0.527)
stageleft=7	−0.052	(0.565)	−0.429	(0.489)
stageleft=8	1.303**	(0.641)	1.407**	(0.596)
stageleft=9			−0.799	(0.504)
Constant	0.977*	(0.511)	1.741***	(0.469)
Observations	1393		3418	
Clusters	81		81	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Ordered logistic regression model for interval between the first and second review

	Model 1 (unprofitable projects)		Model 2 (all projects)	
Independent variable	Coefficient	Robust std. error	Coefficient	Robust std. error
r1sign	−0.929***	(0.173)	−0.726***	(0.138)
cut1	−1.030***	(0.165)	−0.938***	(0.160)
cut2	0.101	(0.125)	0.248**	(0.123)
cut3	0.855***	(0.151)	0.988***	(0.145)
cut4	1.535***	(0.176)	1.851***	(0.179)
cut5	1.689***	(0.195)	2.000***	(0.194)
cut6	5.961***	(0.988)	6.243***	(0.993)
Observations	518		674	
Clusters	38		38	

Notes. If no second review is undertaken, then the second review stage is set equal to the stage of project completion (T).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Online Appendix G: Robustness Check with Increasing Cost Profile

We ran a new series of experiments which considered settings where a profitable project turns into an unprofitable one. Specifically, we let the continuation costs increase over the course of a project such that $c_{t+1} = c_t + 1$. For example, in a 4-stage project, if the initial continuation cost is $c_1 = 10$, then $c_2 = 11$ and $c_3 = 12$. We asked each participant to complete 40 projects. The project paths and initial continuation costs are listed in Table 13. Note that, as in the original experiments, the projects have different lengths (from $T = 4$ to $T = 10$). The projects also differ in initial cost: there are two different initial costs for each project length. We refer to the projects with lower initial costs as "low cost" projects and the ones with higher initial costs as "high cost" projects. The decision points where it is optimal to abandon the project are highlighted in bold in Table 13. For example, as illustrated by projects #11 and #12, for a 6-stage project with initial cost $c_1 = 8$ and initial value $x_1 = 50$, it is optimal to launch the project in the first stage but to abandon it in the second stage if the project value decreases (to $x_2 = 40$).

Table 13: Project paths for increasing cost condition.

Project	T	c_1	Path	Project	T	c_1	Path
1	4	10	**30-20**-30-20	11	6	8	50-60-70-60-70-80
2	4	10	**30**-40-50-60	12	6	8	50-**40**-50-60-50-60
3	4	10	**30**-40-30-40	13	6	8	50-**40-30**-40-50-40
4	4	10	**30**-40-30-20	14	6	8	50-**40-30-20-10**-20
5	4	10	**30-20-10**-20	15	6	8	50-60-50-60-70-60
6	4	11	**30**-40-30-40	16	6	9	**50-40**-50-60-70-60
7	4	11	**30**-40-50-40	17	6	9	**50-40-30-20**-30-20
8	4	11	**30**-40-50-60	18	6	9	**50**-60-50-40-30-40
9	4	11	**30-20**-30-20	19	6	9	**50-40-30**-40-50-60
10	4	11	**30-20-10**-20	20	6	9	**50**-60-70-80-70-60
21	8	6	70-60-70-80-70-80-90-100	31	10	4	90-100-90-80-70-60-70-80-90-80
22	8	6	70-60-50-**40**-50-60-50-60	32	10	4	90-100-110-100-90-100-110-120-110-120
23	8	6	70-80-90-100-90-100-90-80	33	10	4	90-80-90-100-110-120-110-120-130-140
24	8	6	70-80-70-80-90-80-70-80	34	10	4	90-80-70-60-50-**40-30-20**-30-40
25	8	6	70-60-50-**40-30-20-10**-20	35	10	4	90-80-70-80-70-80-90-80-90-100
26	8	7	70-**60-50-40-30-20-10**-20	36	10	5	90-80-70-**60-50-40-30-20**-30-40
27	8	7	70-80-70-60-70-80-90-80	37	10	5	90-80-90-80-70-80-90-100-110-100
28	8	7	70-80-90-80-90-100-90-80	38	10	5	90-80-70-**60**-70-80-90-80-90-100
29	8	7	70-**60**-70-60-70-80-90-100	39	10	5	90-100-90-80-70-60-70-80-90-80
30	8	7	70-**60-50-40**-50-60-50-60	40	10	5	90-100-110-100-90-100-90-100-110-120

Notes. Decision points where it is rational to abandon the project are highlighted in bold.

The setups for the FR and LR treatments are similar to those in the original experiments. To ensure that the participants can easily understand and access information about the continuation costs, we incorporate the changes described in Online Appendix F to make cost salient. There are only two decision points where the rational optimal policies under FR and LR differ: (1) $x_{T-5} = 50$ in low cost projects, and (2) $x_{T-7} = 70$ in high cost projects. For these two decision points, it is optimal to continue if there is at least one review opportunity left; otherwise, the decision maker should be indifferent between continuing and abandoning the project (i.e., the expected value of the project equals the total cost needed to complete the project).

We ran the new experiments in the same venue as the original experiments, and recruited 85 undergraduate students who had not participated in the original experiments or the experiments with salient cost. Overall, 41 subjects participated in the FR experiment and 44 subjects in the LR experiment.

G.1 Experiment Results

Below we present and discuss the data. All results in the original experiments are confirmed, except for the inverted U-shaped effect of path length on abandonment rate—we observe no consistent pattern in the new data. All tables are relegated to the end of this section.

(1) Abandonment rates under FR vs. LR

We find strong support that participants are more likely to abandon an ongoing project under LR than under FR. Tables 14-17 replicate the comparison results and regression analyses in the paper. The results are similar even if we remove the decision points where the optimal policy is different for FR and LR (i.e., $x_{T-5} = 50$ and $x_{T-7} = 70$).

(2) Continue/abandon decisions are path-dependent

We find support for one of the two types of path-dependence we observe in the original experiments.

(2.1) Abandonment rate on downward vs. upward paths

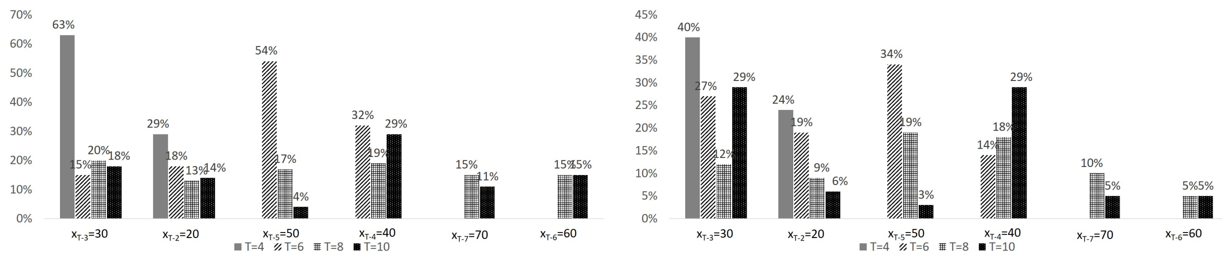
Because we have designed the projects in the new experiments such that, given a certain T, the costs vary but not the initial value, we can no longer make comparisons as in Table 4 in the paper. Nevertheless, the data still suggests that the likelihood of abandonment is higher on downward paths. We find that the abandonment error rate after an observed increase in project value is 0%, compared with 12% on a strictly decreasing path. The difference is significant (Fisher's exact test; $p < 0.01$). As another example, for the same decision point $x_3 = 50$ in a 6-stage high-cost project, the abandonment rate is 0% ($N = 24$) after an observed decrease in project value (i.e., the observed path is $50-40-50$) and 4% ($N = 28$) after an observed decrease in project value (i.e., the observed path is $50-60-50$). This pattern is consistent throughout the data.

(2.2) Abandonment rate near the middle (vs. beginning or end) of a project

We do not observe the inverted U-shaped effect of project length on abandonment rates in the increasing cost data (see Figure 3). We identify a higher tendency to abandon the project in the first stage than in other stages (similar to the experimental results with salient constant cost; see Online Appendix F), but observe no other consistent pattern. This could be due to the different cost profiles in the new treatment which affect the sunk cost bias. Recall that we explain the inverted U-pattern in the original experiments using a combination of gain-loss utility and the sunk cost bias—the former dominates in early stages and the latter dominates in later stages. In this new treatment, the sunk cost bias may start to dominate very early on or very late in the project, depending on the specific decision point and continuation costs.

(3) Review decisions

We confirm all results in the paper regarding the review decision. Tables 18-19 replicate the comparison results and the regression analyses in the paper.



(a) High cost (b) Low cost

Figure 3: Proportion of abandonment in a project on a decreasing-value path; T represents the total number of project stages

Table 14: Abandonment rates under FR versus LR (high cost).

	Abandonment rate			Abandonment rate			Abandonment rate	
	FR	LR		FR	LR		FR	LR
$T=4$			$T=8$			$T=10$		
$x_1=30$	63%	50%	$x_1=70$	25%	15%	$x_1=90$	7%	2%
	$(N=205)$	$(N=220)$		$(N=205)$	$(N=220)$		$(N=205)$	$(N=220)$
$x_2=20$	29%	56%	$x_2=60$	15%	15%	$x_2=80$	2%	4%
	$(N=28)$	$(N=34)$		$(N=89)$	$(N=34)$		$(N=114)$	$(N=24)$
$x_3=10$	11%	50%	$x_3=50$	17%	45%	$x_3=70$	11%	16%
	$(N=9)$	$(N=6)$		$(N=52)$	$(N=47)$		$(N=75)$	$(N=31)$
			$x_4=40$	19%	38%	$x_4=60$	25%	63%
$T=6$				$(N=43)$	$(N=29)$		$(N=67)$	$(N=40)$
$x_1=50$	54%	40%	$x_5=30$	20%	63%	$x_5=50$	4%	47%
	$(N=205)$	$(N=220)$		$(N=20)$	$(N=8)$		$(N=25)$	$(N=17)$
$x_2=40$	32%	27%	$x_6=20$	13%	100%	$x_6=40$	29%	38%
	$(N=57)$	$(N=51)$		$(N=16)$	$(N=2)$		$(N=24)$	$(N=8)$
$x_3=30$	15%	42%				$x_7=30$	18%	33%
	$(N=27)$	$(N=33)$					$(N=17)$	$(N=3)$
$x_4=20$	18%	14%				$x_8=20$	14%	50%
	$(N=11)$	$(N=7)$					$(N=14)$	$(N=2)$

Notes. N = number of observations.

Table 15: Abandonment rates under FR versus LR (low cost).

	Abandonment rate			Abandonment rate			Abandonment rate	
	FR	LR		FR	LR		FR	LR
$T = 4$			$T = 8$			$T = 10$		
$x_1 = 30$	40%	37%	$x_1 = 70$	10%	2%	$x_1 = 90$	4%	1%
	$(N = 205)$	$(N = 220)$		$(N = 205)$	$(N = 220)$		$(N = 205)$	$(N = 220)$
$x_2 = 20$	24%	39%	$x_2 = 60$	5%	12%	$x_2 = 80$	3%	15%
	$(N = 46)$	$(N = 46)$		$(N = 111)$	$(N = 33)$		$(N = 118)$	$(N = 20)$
$x_3 = 10$	17%	29%	$x_3 = 50$	19%	39%	$x_3 = 70$	5%	17%
	$(N = 18)$	$(N = 7)$		$(N = 70)$	$(N = 51)$		$(N = 77)$	$(N = 23)$
			$x_4 = 40$	18%	43%	$x_4 = 60$	5%	22%
$T = 6$				$(N = 57)$	$(N = 30)$		$(N = 37)$	$(N = 18)$
$x_1 = 50$	34%	16%	$x_5 = 30$	12%	62%	$x_5 = 50$	3%	50%
	$(N = 205)$	$(N = 220)$		$(N = 26)$	$(N = 13)$		$(N = 35)$	$(N = 18)$
$x_2 = 40$	14%	25%	$x_6 = 20$	9%	60%	$x_6 = 40$	29%	0%
	$(N = 80)$	$(N = 59)$		$(N = 23)$	$(N = 5)$		$(N = 34)$	$(N = 4)$
$x_3 = 30$	27%	46%	$x_7 = 10$	5%	100%	$x_7 = 30$	29%	43%
	$(N = 45)$	$(N = 54)$		$(N = 21)$	$(N = 1)$		$(N = 24)$	$(N = 7)$
$x_4 = 20$	41%	44%				$x_8 = 20$	6%	50%
	$(N = 17)$	$(N = 9)$					$(N = 17)$	$(N = 4)$
$x_5 = 10$	20%	100%				$x_8 = 20$	6%	50%
	$(N = 10)$	$(N = 1)$					$(N = 17)$	$(N = 4)$

Notes. N = number of observations.

Table 16: Logistic regression model for continue decision in FR vs. LR experiment (high cost).

	Model 1 (excluding stage 1)		Model 2 (including stage 1)	
Independent variable	Coefficient	Robust std. error	Coefficient	Robust std. error
FR	1.025^{***}	(0.259)	0.041	(0.215)
stageleft=2	-0.659	(0.487)	-0.828^{*}	(0.495)
stageleft=3	-0.458	(0.573)	-1.591^{***}	(0.542)
stageleft=4	-0.453	(0.534)	-0.654	(0.528)
stageleft=5	-0.354	(0.515)	-1.228^{**}	(0.521)
stageleft=6	-0.415	(0.531)	-0.522	(0.535)
stageleft=7	0.515	(0.560)	-0.084	(0.520)
stageleft=8	2.233^{***}	(0.789)	2.237^{***}	(0.801)
stageleft=9			1.563^{**}	(0.685)
Constant	0.813	(0.509)	1.536^{***}	(0.501)
Observations	2778		1078	
Clusters	85		85	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Logistic regression model for continue decision in FR vs. LR experiment (low cost).

	Model 1 (excluding stage 1)		Model 2 (including stage 1)	
Independent variable	Coefficient	Robust std. error	Coefficient	Robust std. error
FR	1.133***	(0.239)	0.158	(0.183)
stageleft=2	−0.396	(0.436)	−0.625	(0.437)
stageleft=3	−0.607	(0.435)	−1.006**	(0.431)
stageleft=4	−0.076	(0.441)	−0.292	(0.438)
stageleft=5	−0.160	(0.439)	−0.402	(0.440)
stageleft=6	1.111**	(0.538)	0.955*	(0.531)
stageleft=7	1.009*	(0.544)	1.184**	(0.496)
stageleft=8	1.379**	(0.672)	1.359**	(0.667)
stageleft=9			2.216***	(0.675)
Constant	0.667	(0.429)	1.436***	(0.451)
Observations	2969		1269	
Clusters	85		85	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 18: Proportion of first review by stage.

Project length		Proportion of first review decision							
and initial cost	N	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9
$T = 4$									
$c_1 = 10$	138	76%	22%						
$c_1 = 11$	110	75%	23%						
$T = 6$									
$c_1 = 8$	184	57%	36%	4%	1%				
$c_1 = 9$	132	63%	34%	3%	1%				
$T = 8$									
$c_1 = 6$	216	27%	42%	22%	6%	1%	0%		
$c_1 = 7$	186	30%	44%	22%	1%	1%	1%		
$T = 10$									
$c_1 = 4$	218	18%	24%	33%	17%	6%	0%	1%	0%
$c_1 = 5$	216	18%	27%	33%	14%	4%	1%	0%	1%

Notes. N = number of observations.

Table 19: Ordered logistic regression model for interval between the first and second review

Independent variable	Coefficient	Robust std. error
r1sign	-0.708^{***}	(0.132)
cut1	-0.674^{***}	(0.152)
cut2	0.365^{***}	(0.123)
cut3	1.175^{***}	(0.122)
cut4	1.771^{***}	(0.140)
cut5	1.851^{***}	(0.150)
cut6	5.528^{***}	(0.559)
Observations	1004	
Clusters	44	

Notes. If no second review is undertaken, then the second review stage is set equal to the stage of project completion (T).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$